

Atlas of Human Anatomy



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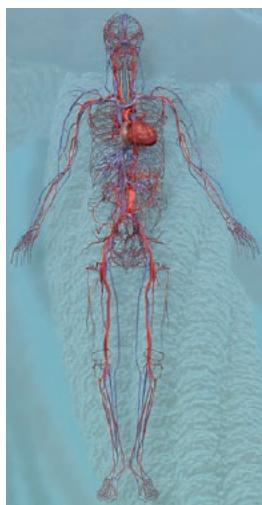
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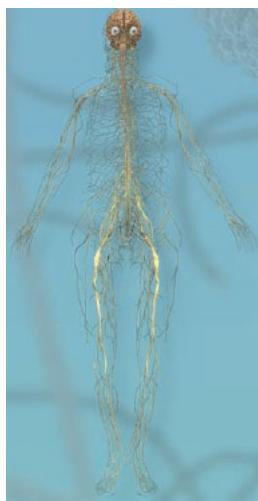
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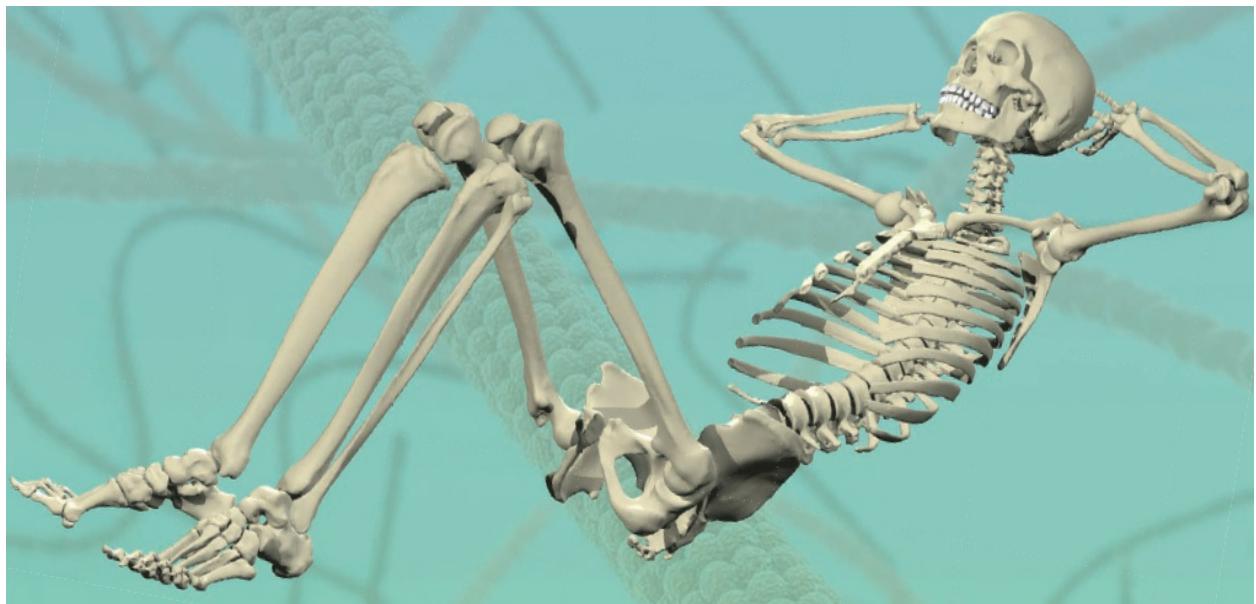
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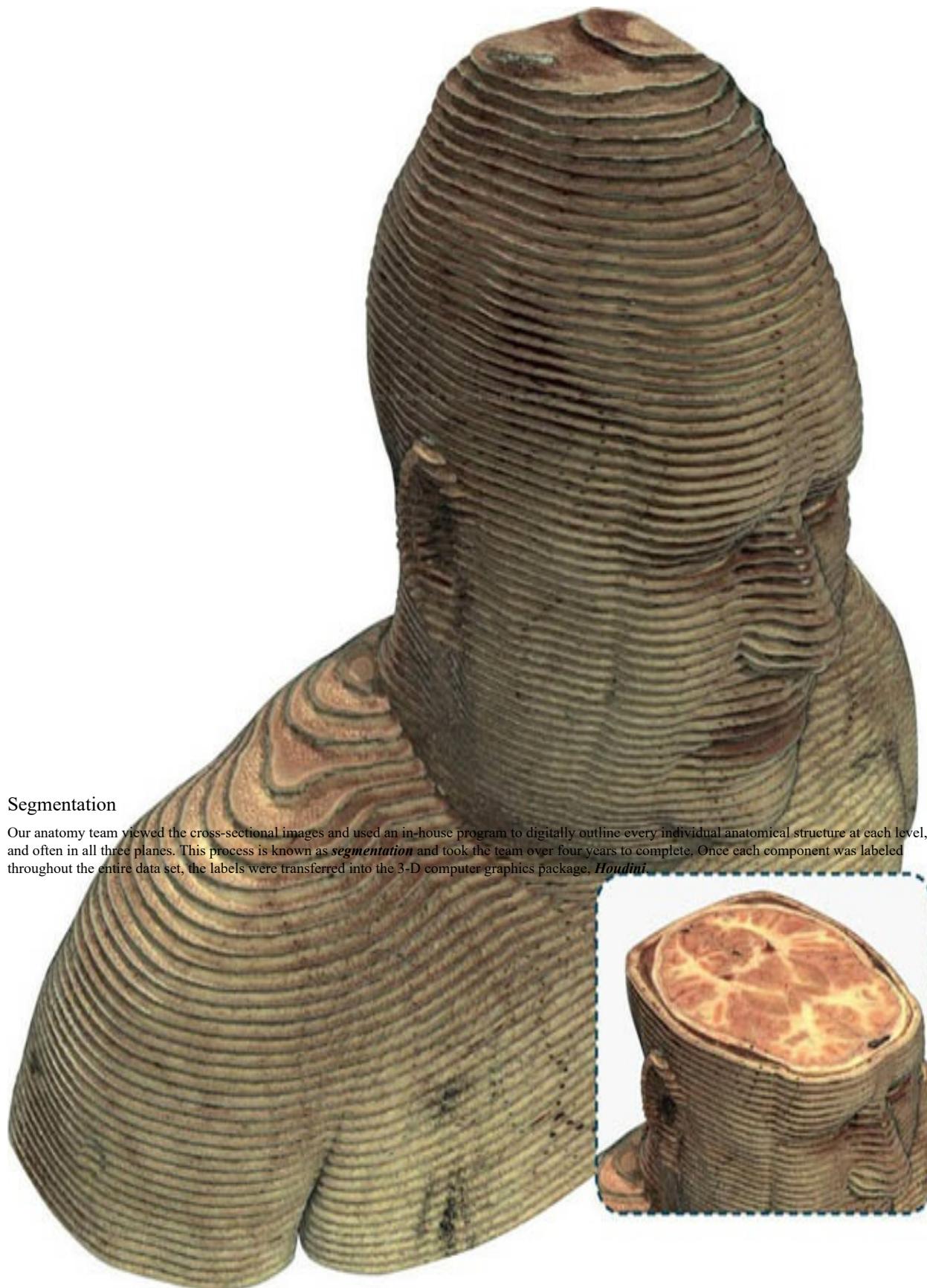
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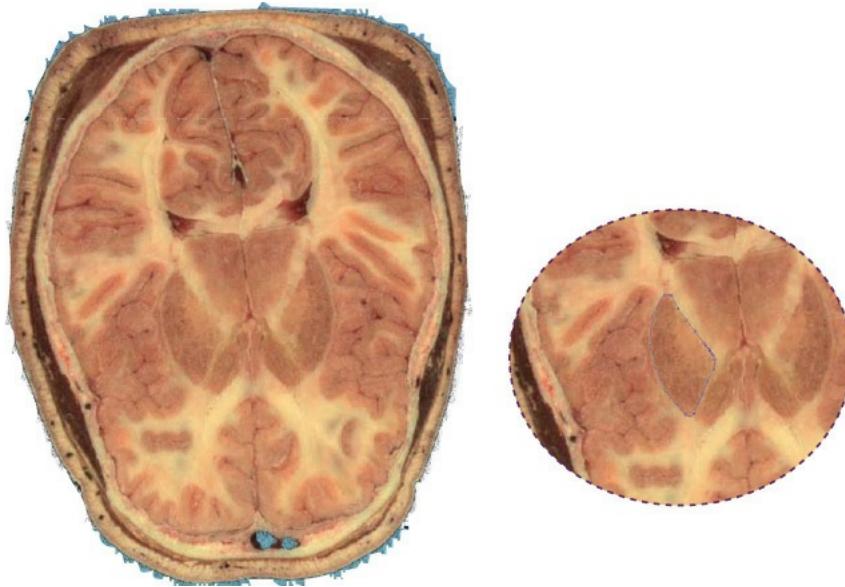






Segmentation

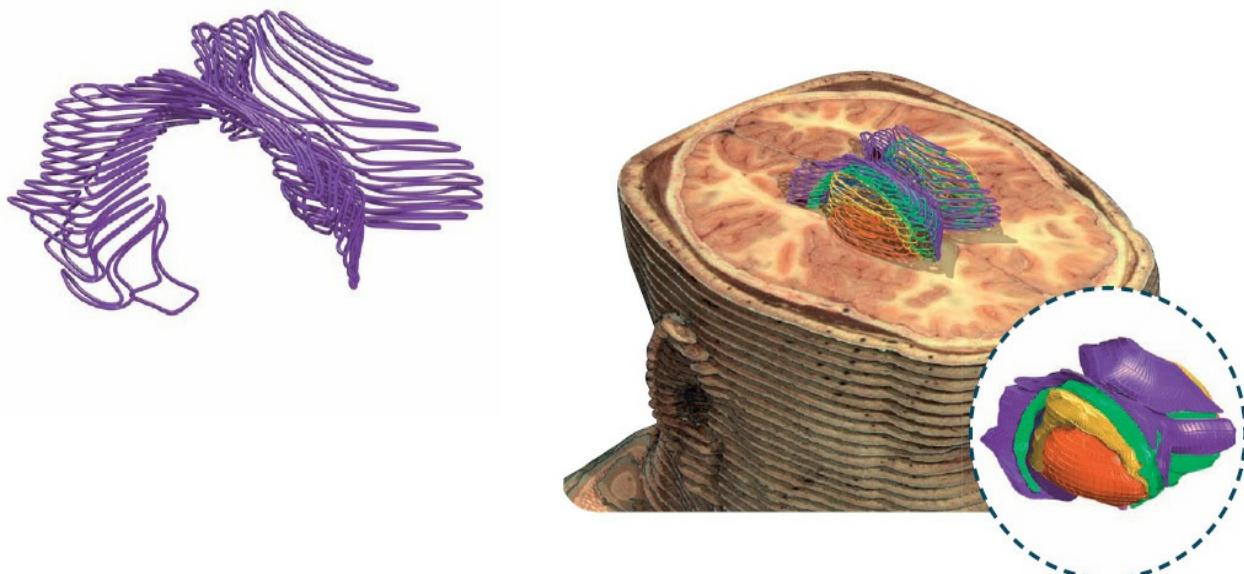
Our anatomy team viewed the cross-sectional images and used an in-house program to digitally outline every individual anatomical structure at each level, and often in all three planes. This process is known as *segmentation* and took the team over four years to complete. Once each component was labeled throughout the entire data set, the labels were transferred into the 3-D computer graphics package, *Houdini*.



This image shows a label around the **caudate nucleus** of the brain on an axial slice.

Splines

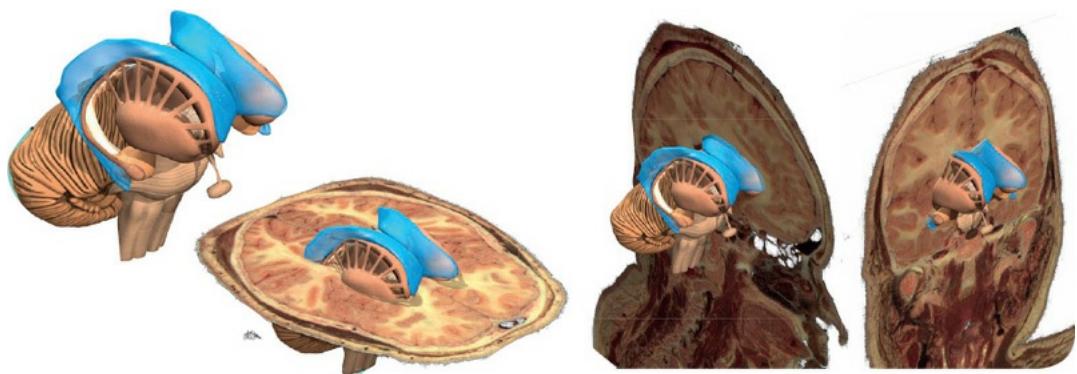
In Houdini, the graphics team used the labels to create a 3-D shape of each anatomical component. Here are the rings for the lateral ventricles of the brain seen in axial, sagittal, and coronal directions, and combined together.



The sets of rings taken were then skinned and manually manipulated to provide smooth realistic shapes.

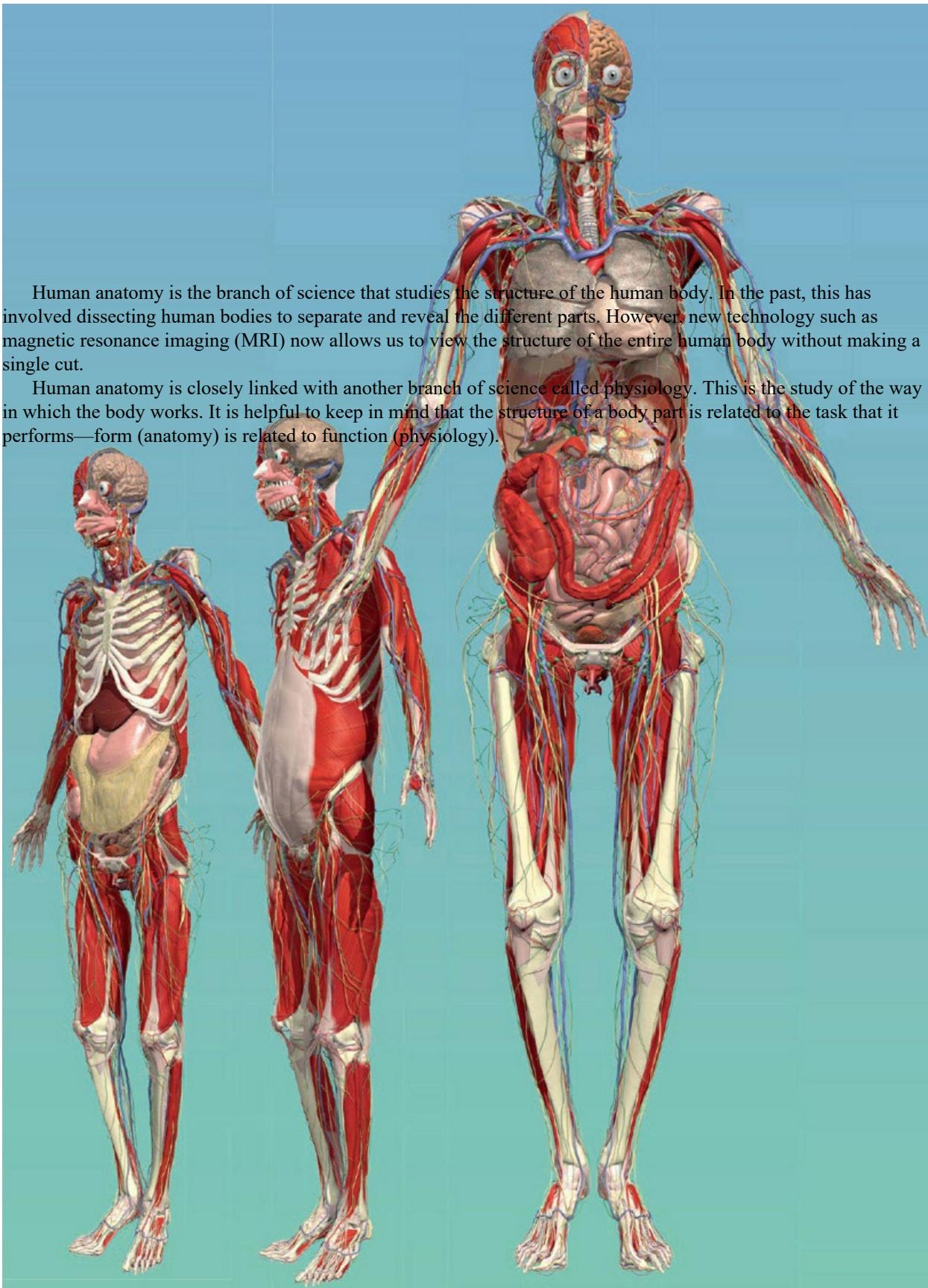
Final model

Smaller components that could not be segmented, such as small ligaments and vessels were hand-modeled and the 3-D model was textured and rendered to produce the images you can see in this book.



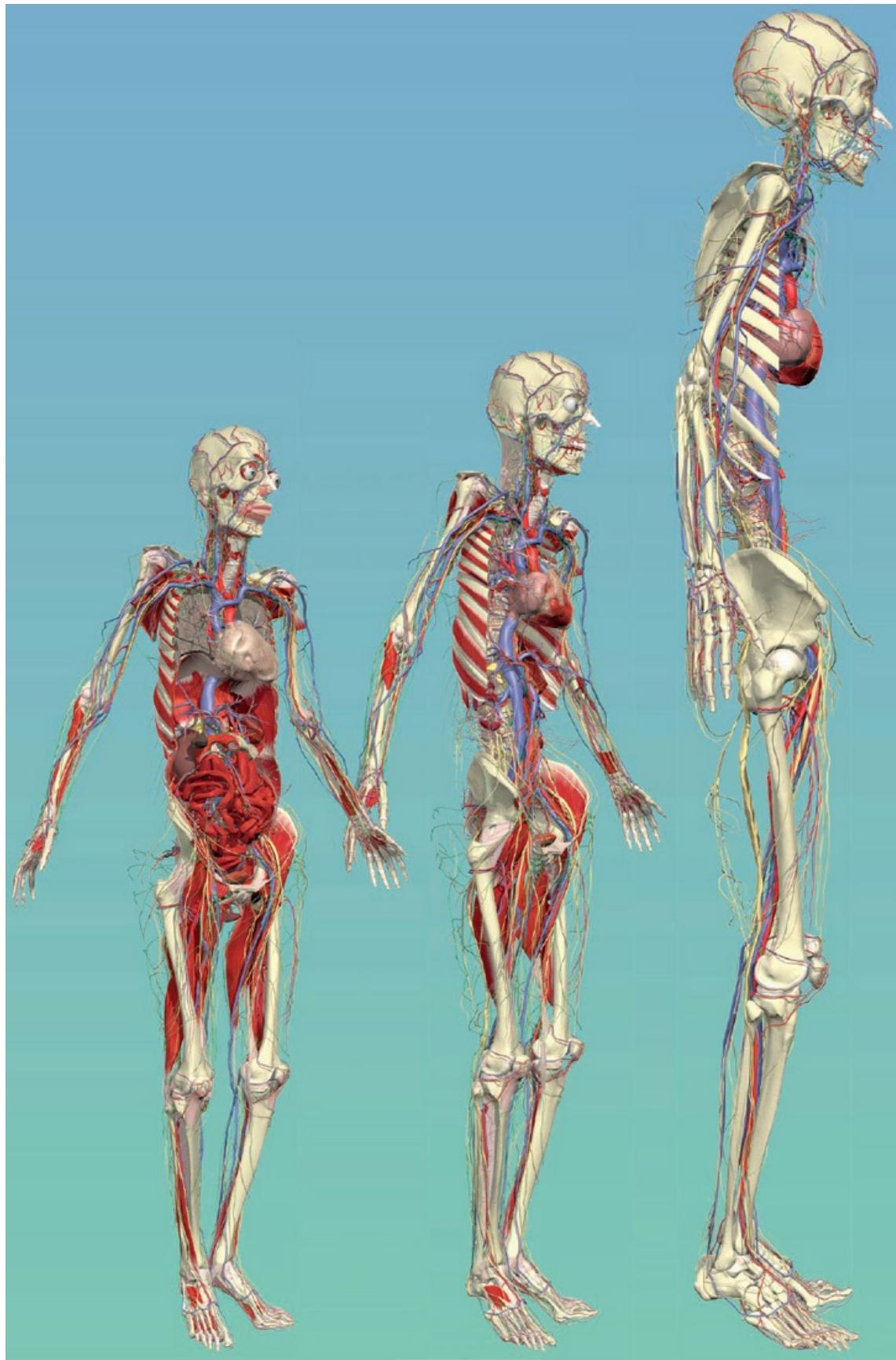
WHOLE BODY OVERVIEW

The human body is truly amazing. At this very moment numerous chemical reactions are taking place within the trillions of specialized cells that make up our tissues, organs, and systems. Working together, they allow us to move, to grow, to breathe, to eat, to react to our environment, and even to interact with one another. Thanks to our incredible bodies, we are living organisms that not only survive, but thrive, here on planet Earth. As we take this journey through the human body we will see the remarkable way in which the body is adapted and organized to allow this to happen.



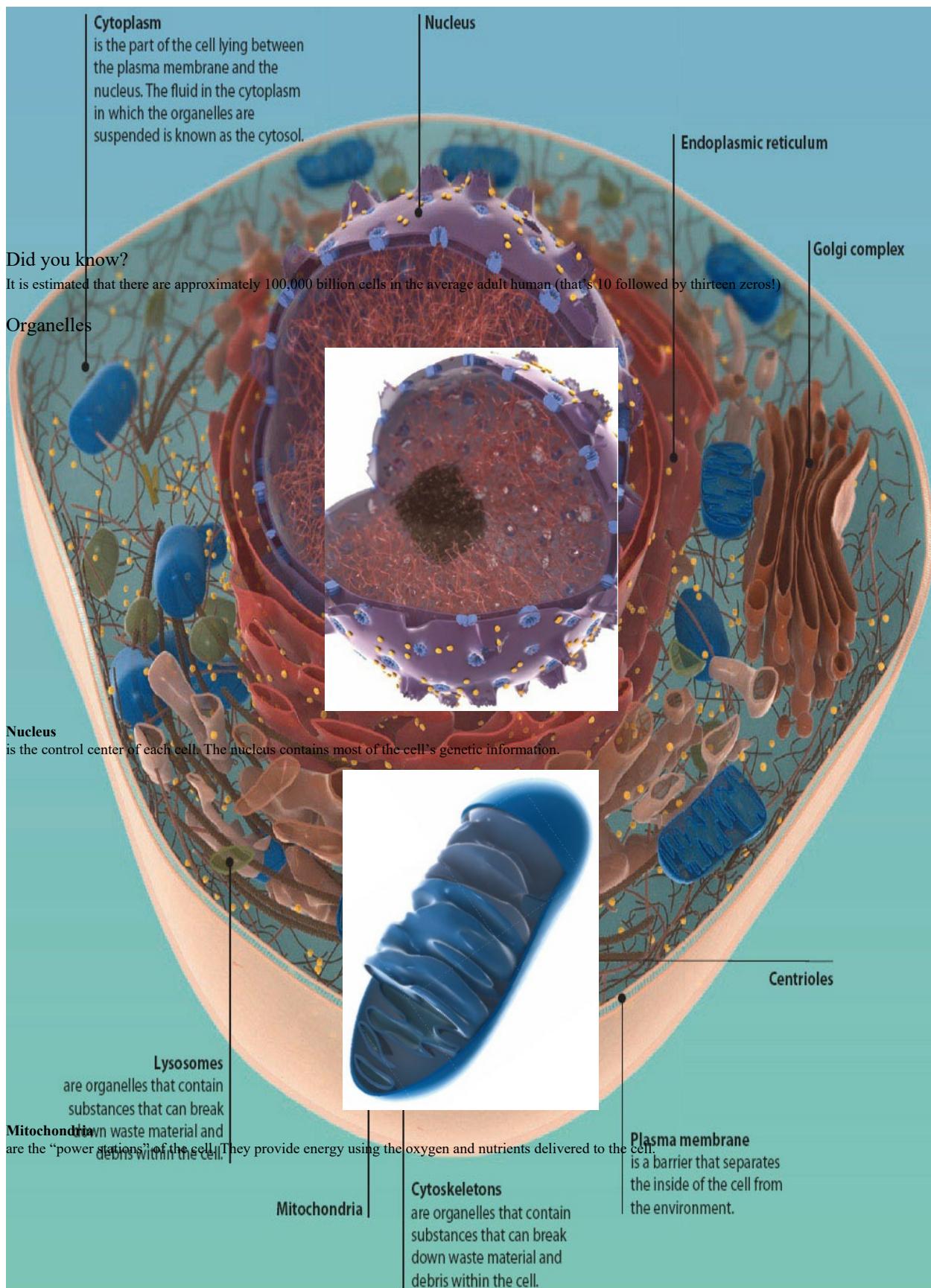
Human anatomy is the branch of science that studies the structure of the human body. In the past, this has involved dissecting human bodies to separate and reveal the different parts. However, new technology such as magnetic resonance imaging (MRI) now allows us to view the structure of the entire human body without making a single cut.

Human anatomy is closely linked with another branch of science called physiology. This is the study of the way in which the body works. It is helpful to keep in mind that the structure of a body part is related to the task that it performs—form (anatomy) is related to function (physiology).



GENERALIZED CELL

A cell is the smallest individual building block of a living organism. There are many different types of cell, depending upon the substances they produce and the functions they perform. Examples include skin, muscle, and nerve cells. Each cell contains organelles which are specialized regions within a cell that work together to keep the cell alive, and to help it carry out its function.





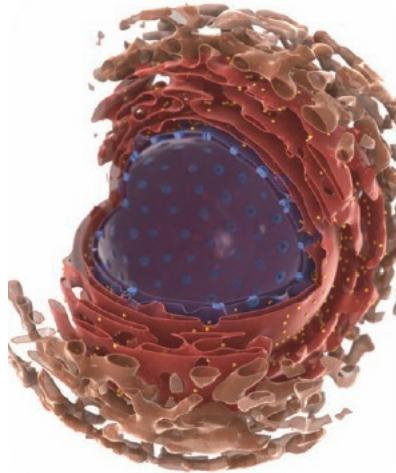
Golgi complex

can be thought of as an “intracellular post office.” Products made by the cell are labeled and packaged for delivery to other areas, or for export out of the cell.



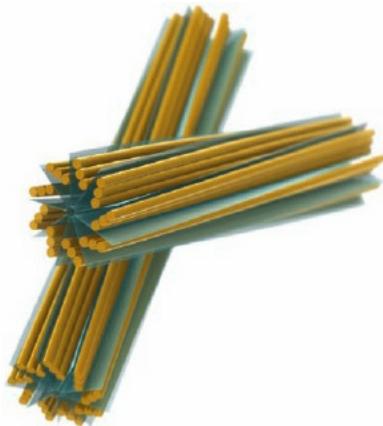
Cytoskeleton

provides structural support for the cell as well as helping move things from one part of the cell to another.



Endoplasmic reticulum

is involved in producing and processing proteins. In some cells it also has a role in the processing of fats and sugars.



Centrioles

are specialized structures involved in cell division.

CELL DIVISION

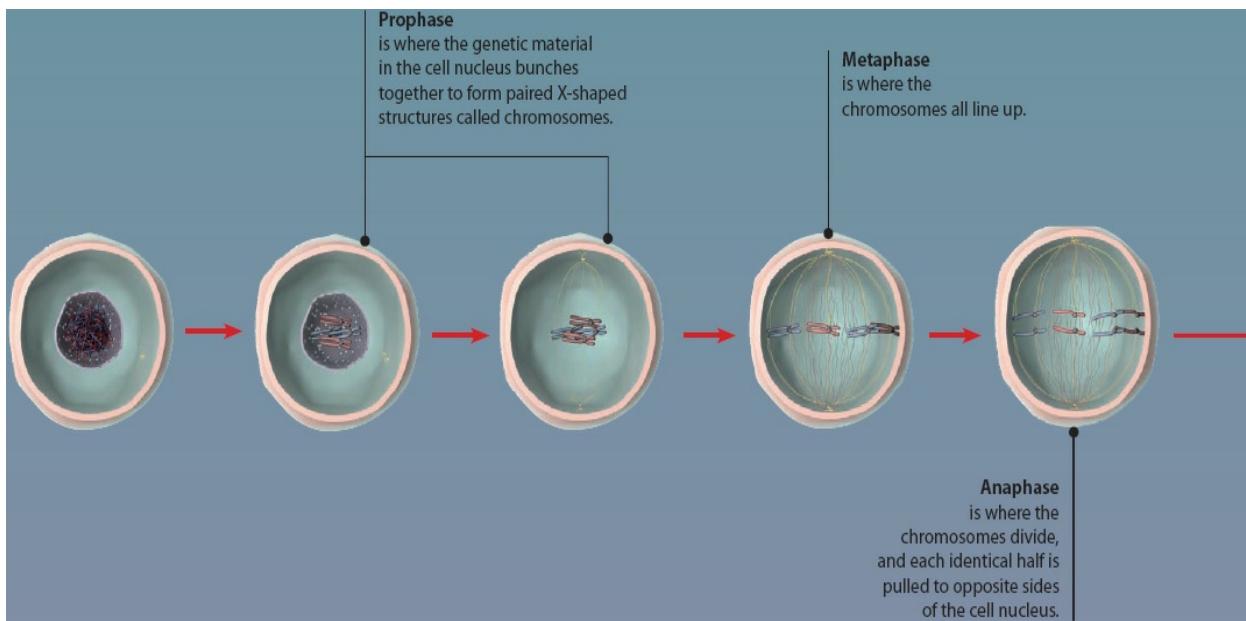
Most cells in the human body are able to divide. There are two methods of cell division, mitosis and meiosis. These processes are divided into different phases.

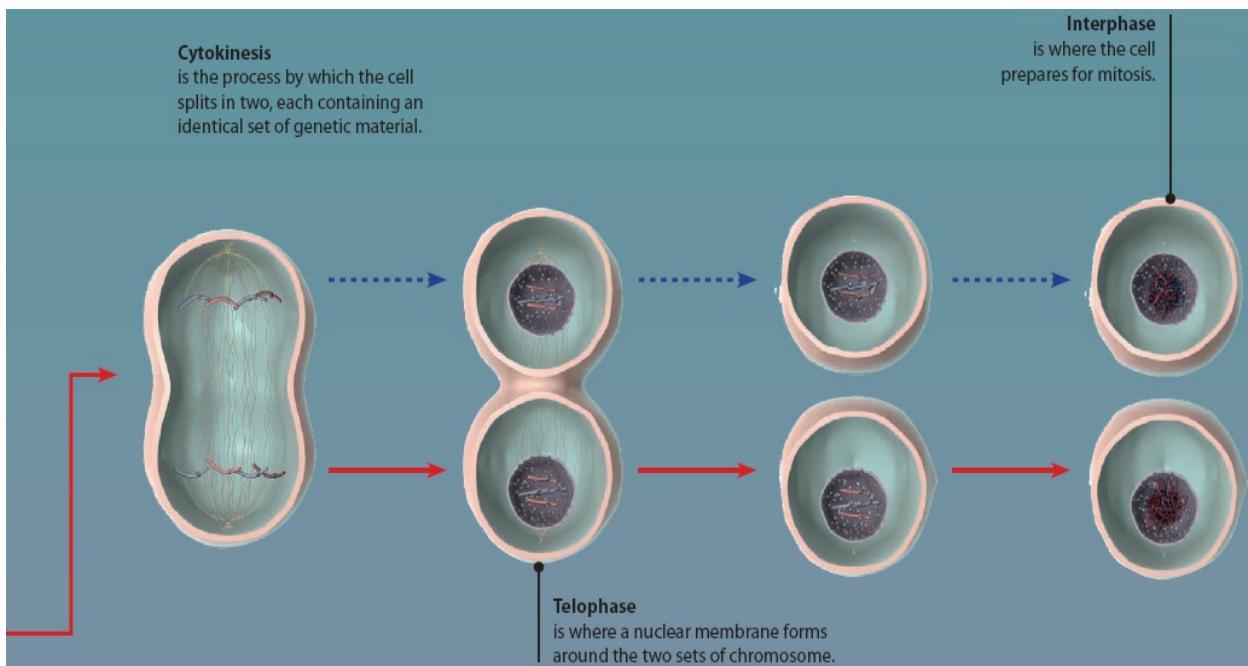
Body (somatic) cells divide by mitosis. This produces two genetically identical copies of the parent cell, which can replace worn out cells, and allow growth to occur.

Reproductive (germ) cells divide by meiosis. This produces four genetically unique cells called gametes (either sperm or egg cells), which have half ($1n$) the genetic material of the parent cell. Gametes allow reproduction and the creation of a new human being.

Mitosis

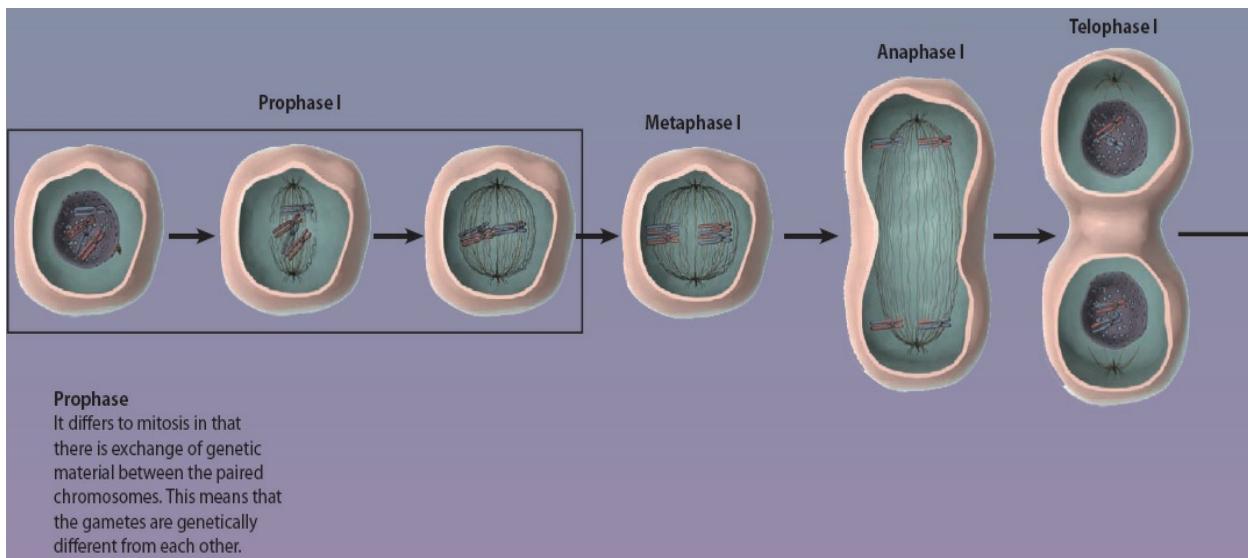
is the type of cell division that takes place in body (somatic) cells.

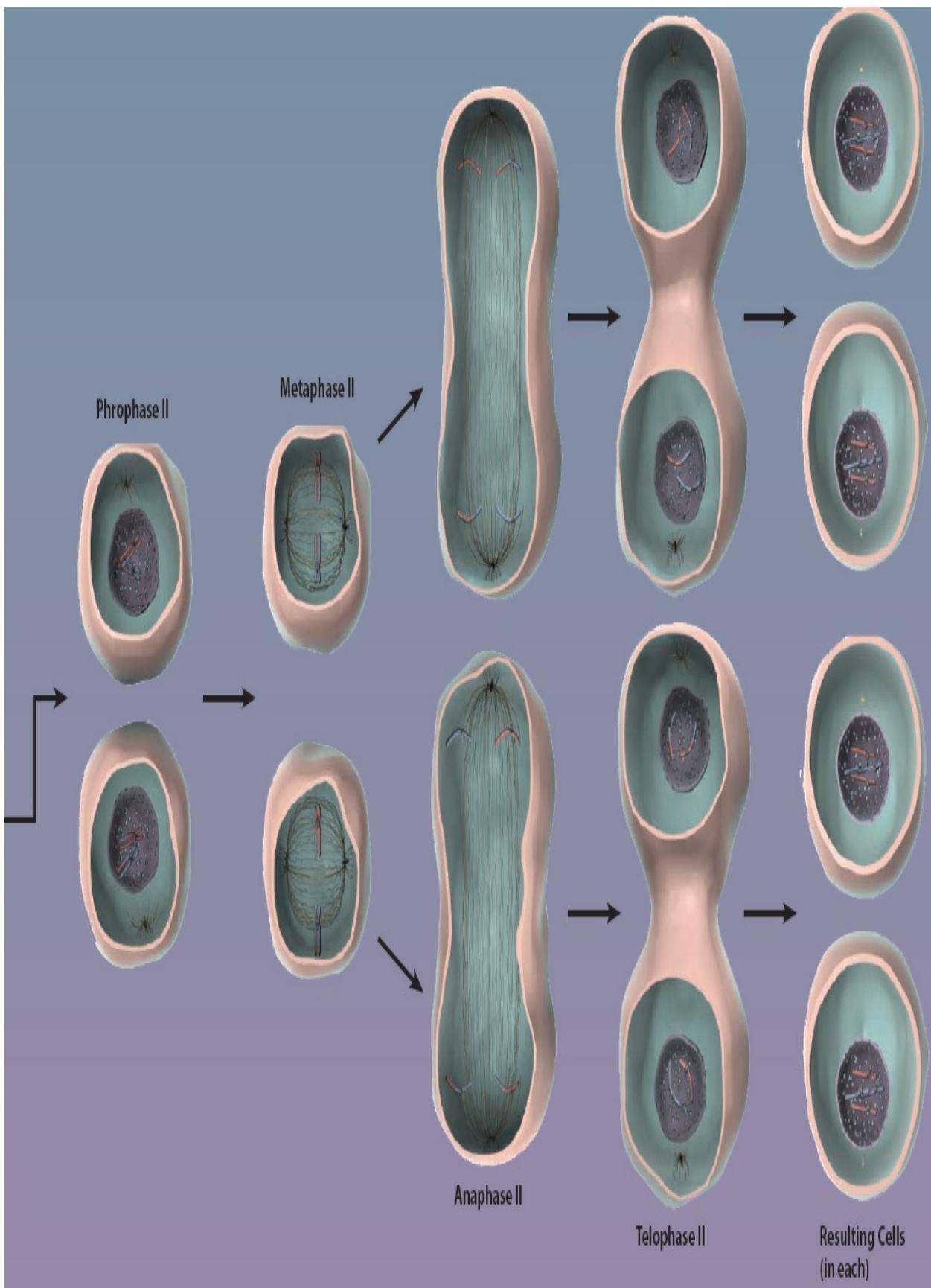




Meiosis

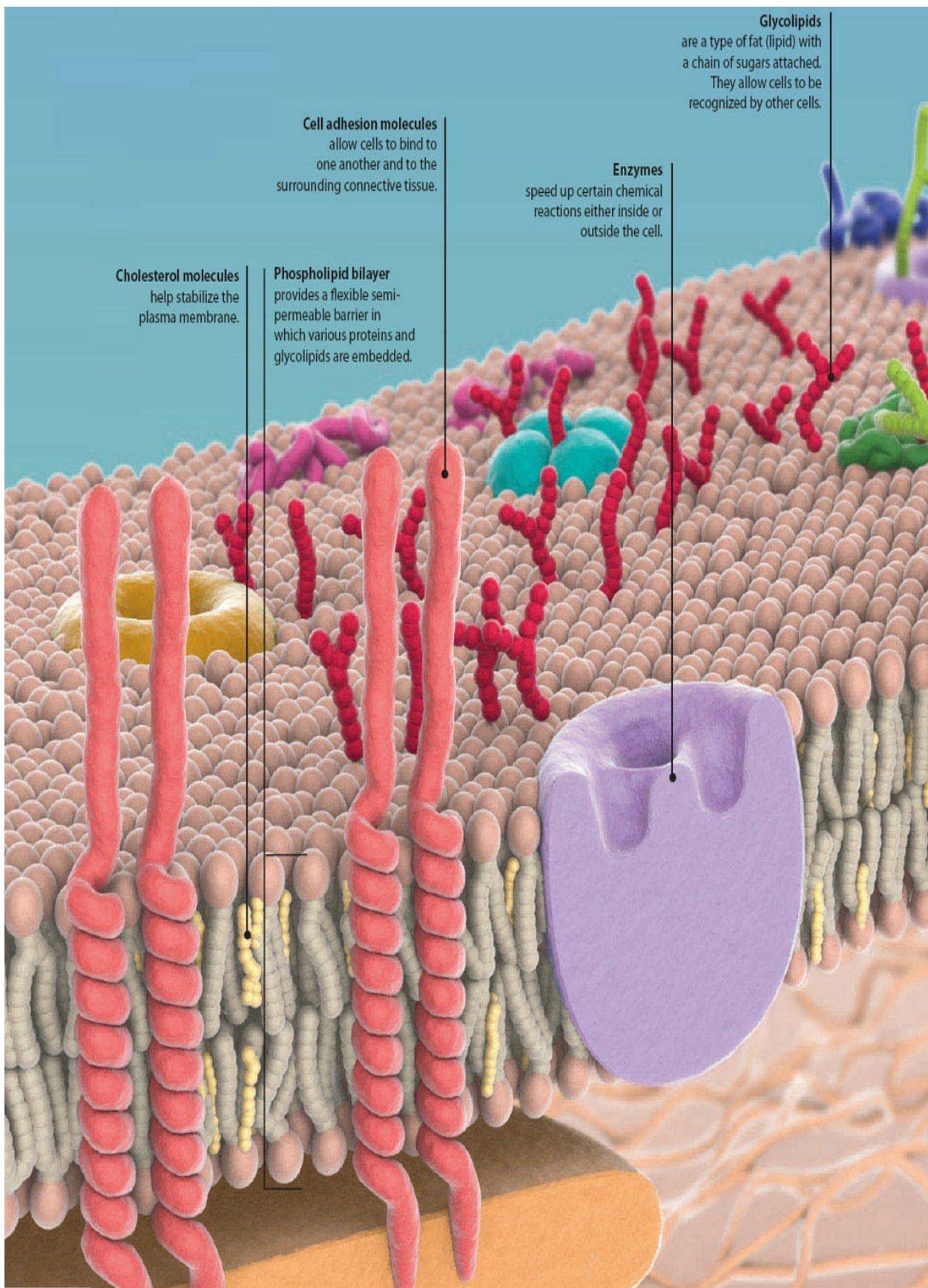
is the type of cell division that takes place in reproductive (germ) cells. It is a two-step process. The key difference to mitosis is that the resulting cells have only half the normal content of genetic material.





PLASMA MEMBRANE

The plasma membrane is a flexible barrier that separates and protects the cell contents from the outside environment. It is selectively permeable, which means that only certain substances can pass through it. This allows the plasma membrane to control what enters and leaves the cell, and to precisely regulate the environment within the cell. The plasma membrane is formed by two layers of phospholipids, within which cholesterol and various specialized proteins are embedded. These proteins are the cell's main way of interacting with the external environment, and they include channels, signals, receptors, carriers, and enzymes.



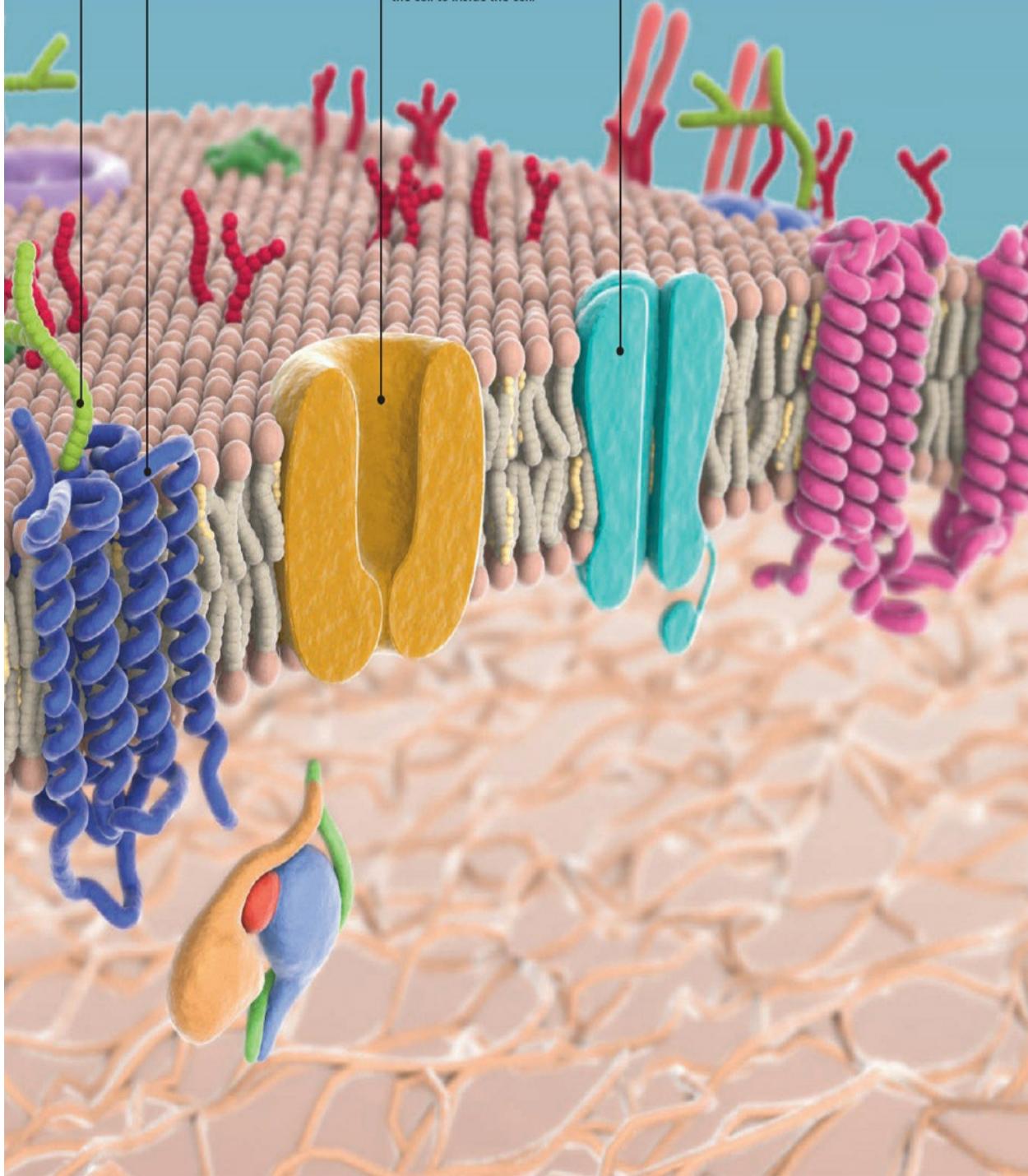
Plasma Membrane

Cell identification molecules allow cells to signal and communicate with each other.

Receptor proteins detect when specific molecules bind to them, often leading to a change in cell behavior.

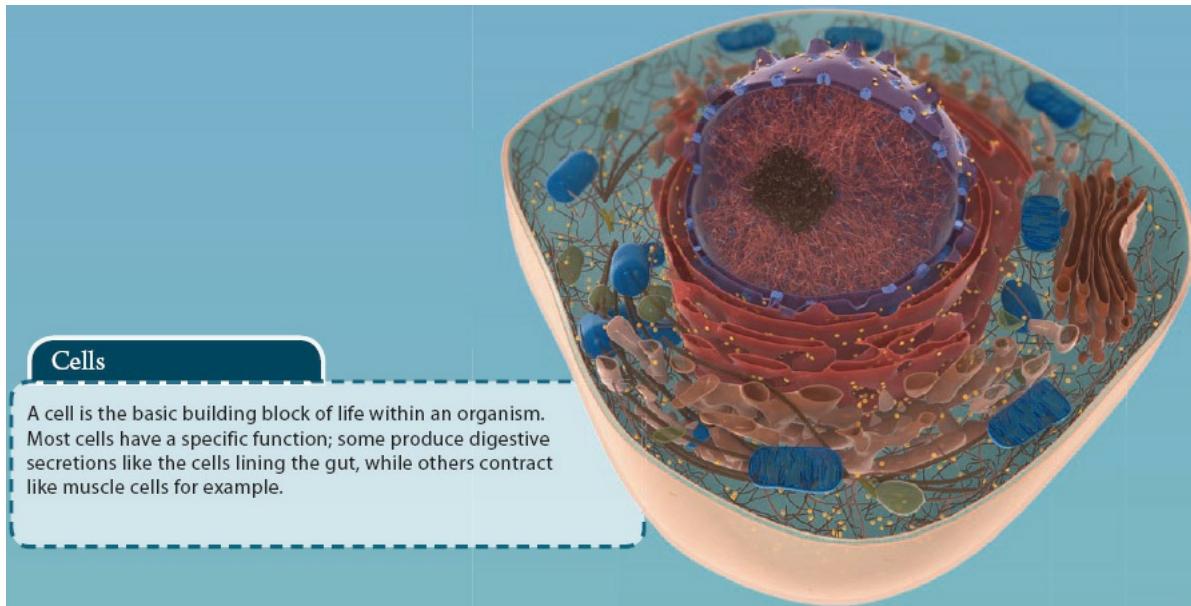
Carrier proteins can undergo shape changes which allow them to move large molecules from outside the cell to inside the cell.

Channel proteins allow the passage of certain chemical substances, depending upon their size and electrical charge.



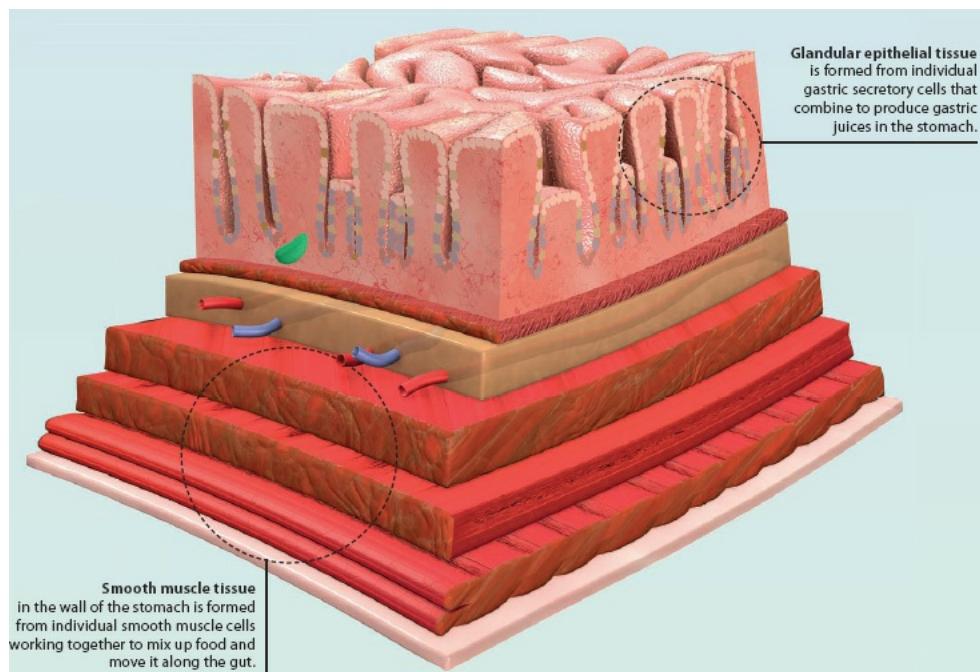
ORGANIZATION OF TISSUES

The human body contains trillions of individual cells. To maximize efficiency and function, this vast number of cells are organized and grouped according to the function that they perform. This leads to a hierarchy of cells, tissues, organs, systems, and organisms, where each level increases in both structural and functional complexity.



Tissue

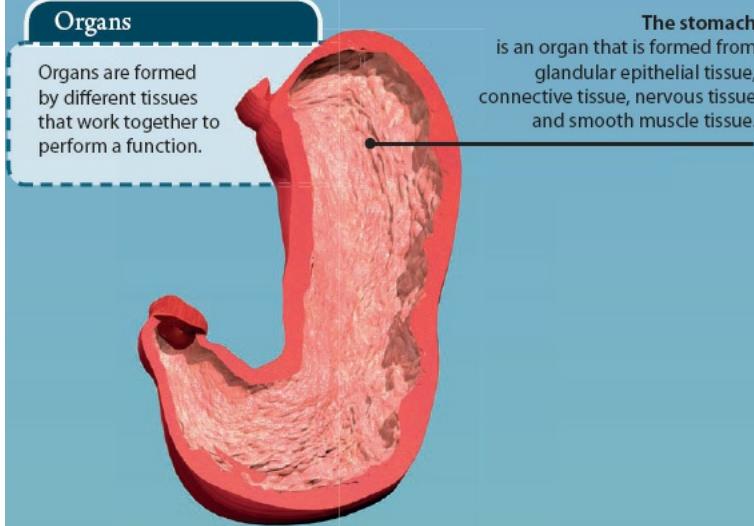
Tissue is formed from collections of cells that perform the same function.



Organs

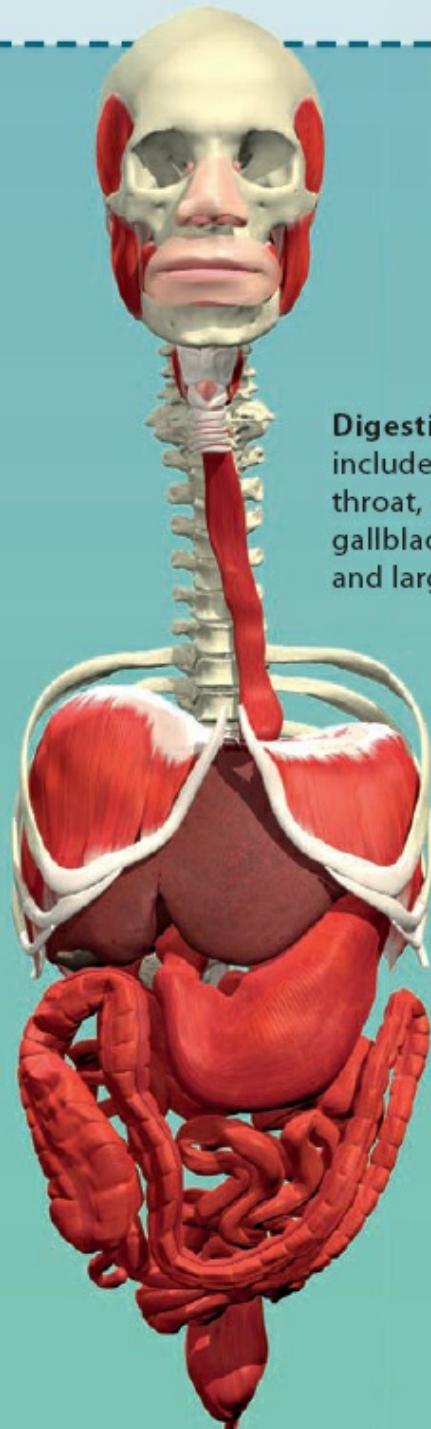
Organs are formed by different tissues that work together to perform a function.

The stomach is an organ that is formed from glandular epithelial tissue, connective tissue, nervous tissue and smooth muscle tissue.



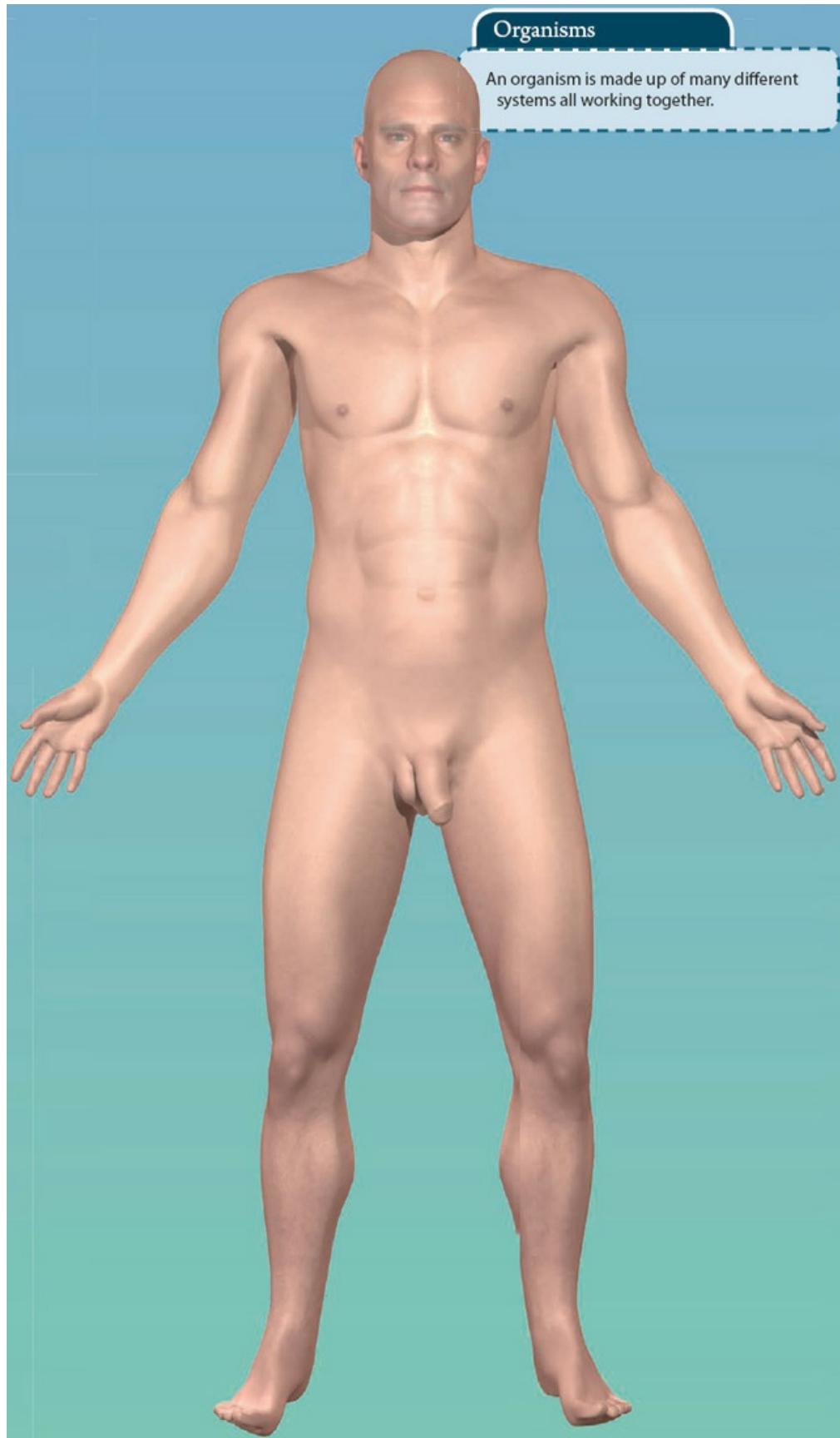
Systems

Systems are any organs working together to produce the same effect. Some organs may belong to more than one system.



Digestive system

includes the mouth, salivary glands, throat, esophagus, stomach, liver, gallbladder, pancreas, and small and large intestines.



CHAPTER 1 : SYSTEMS

The human body is arranged so that all the specialized processes necessary for it to survive and reproduce are carried out by different systems.

To avoid confusion, anatomy has developed its own language. Specific anatomical terms are used to describe the different regions of the body. There is a standard anatomical position of a person standing with their arms by their side, and palm of the hands facing forwards. This allows people to describe different structures in relation to each other. Different sections can be used to divide the body, and standard terms are used to define these planes and the views they produce.

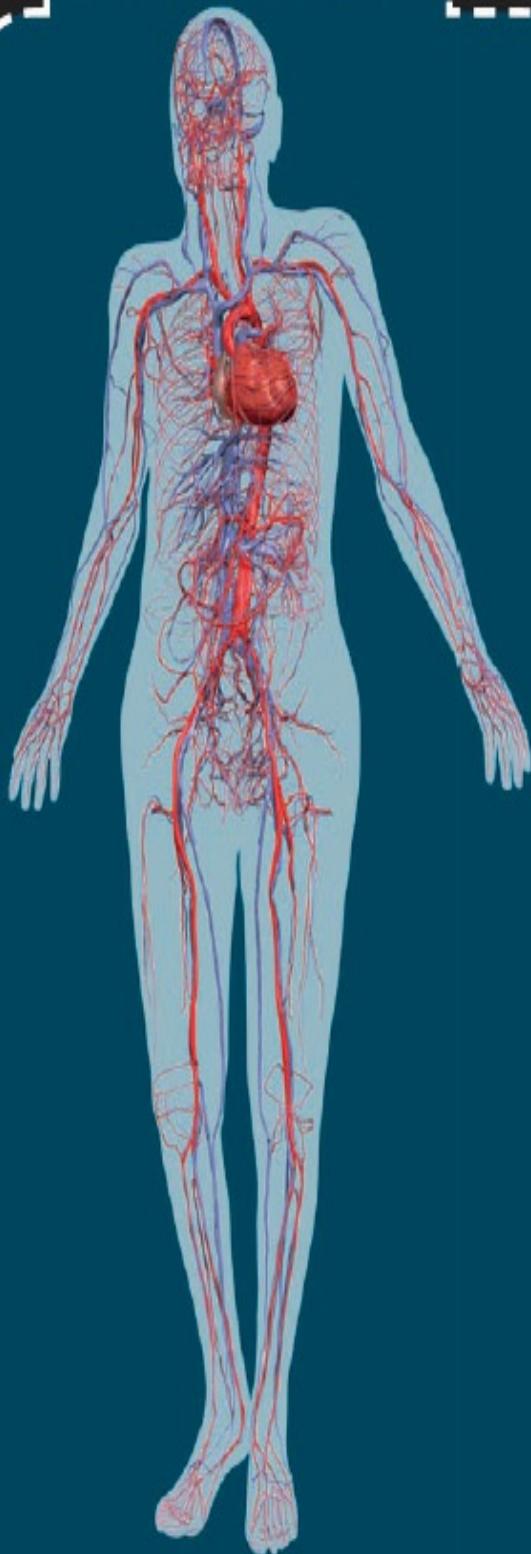
Skeletal System



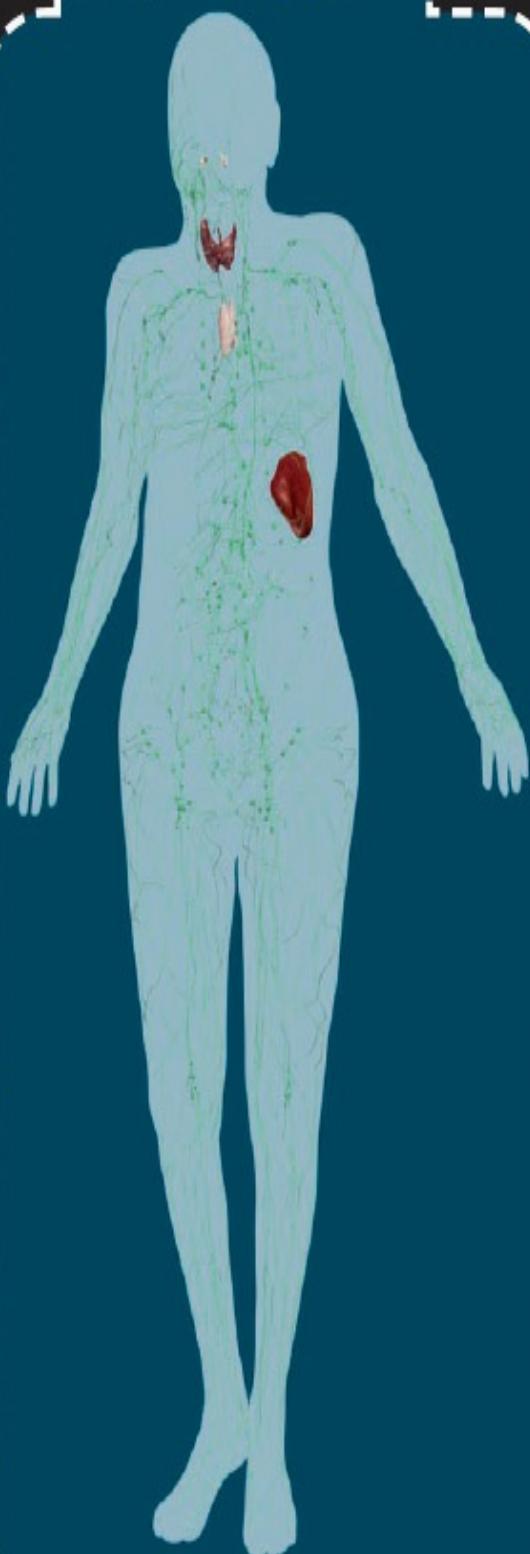
Muscular System



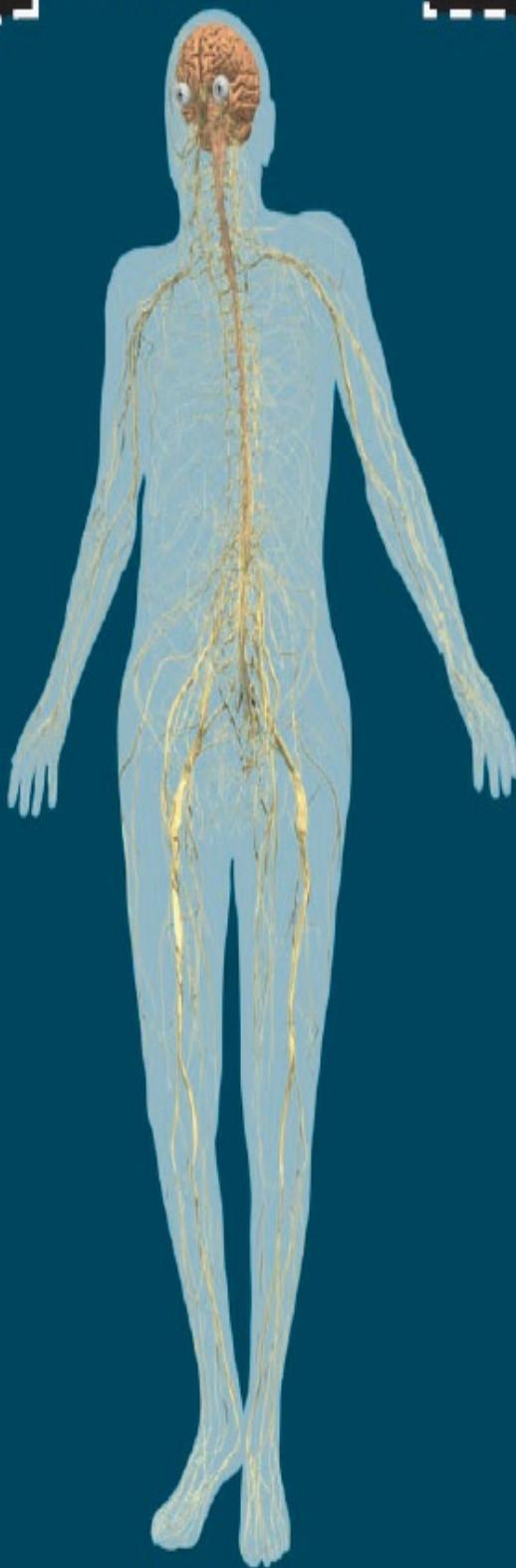
Cardiovascular System



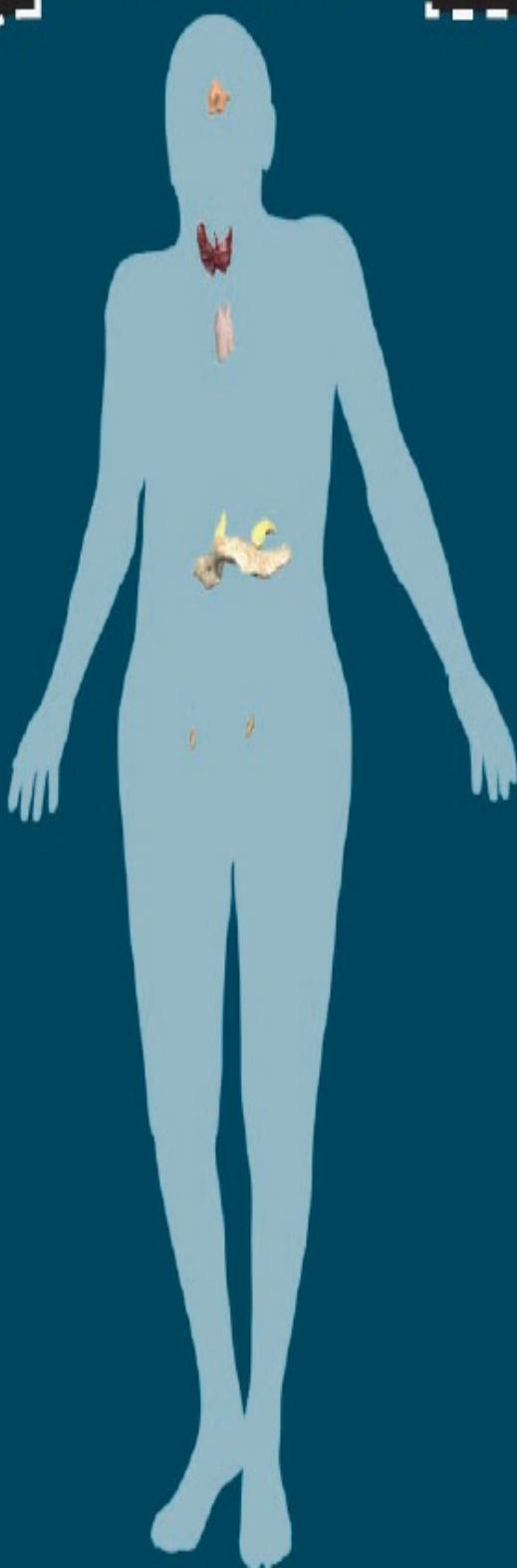
Lymphatic System



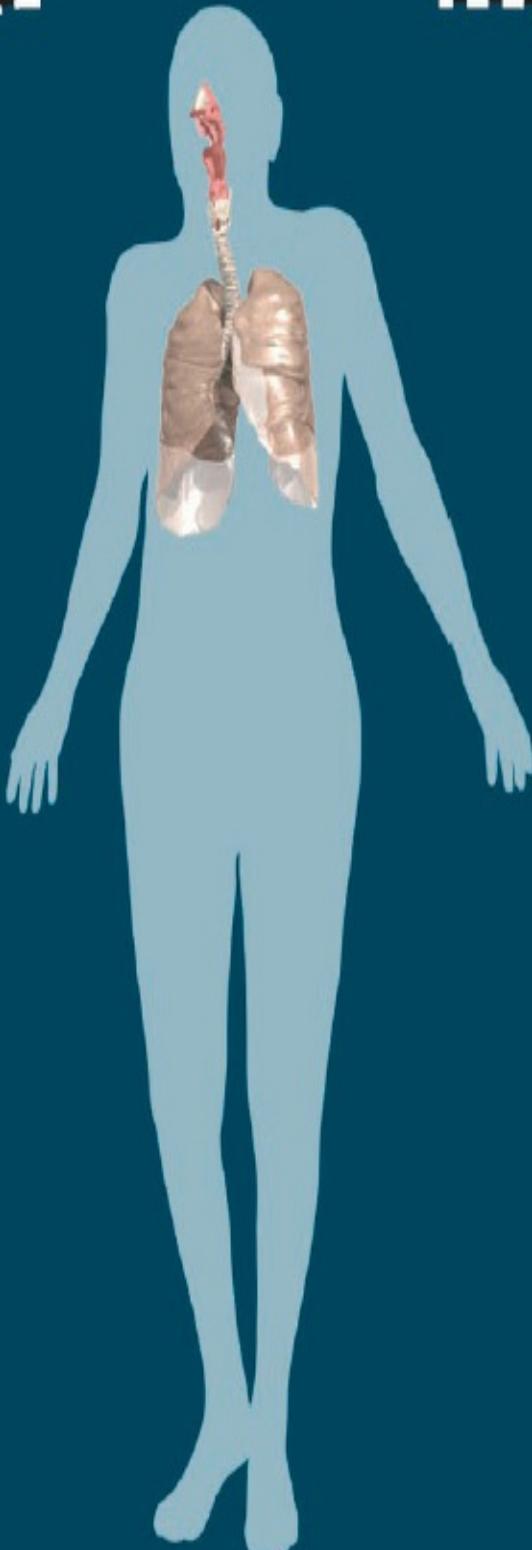
Nervous System



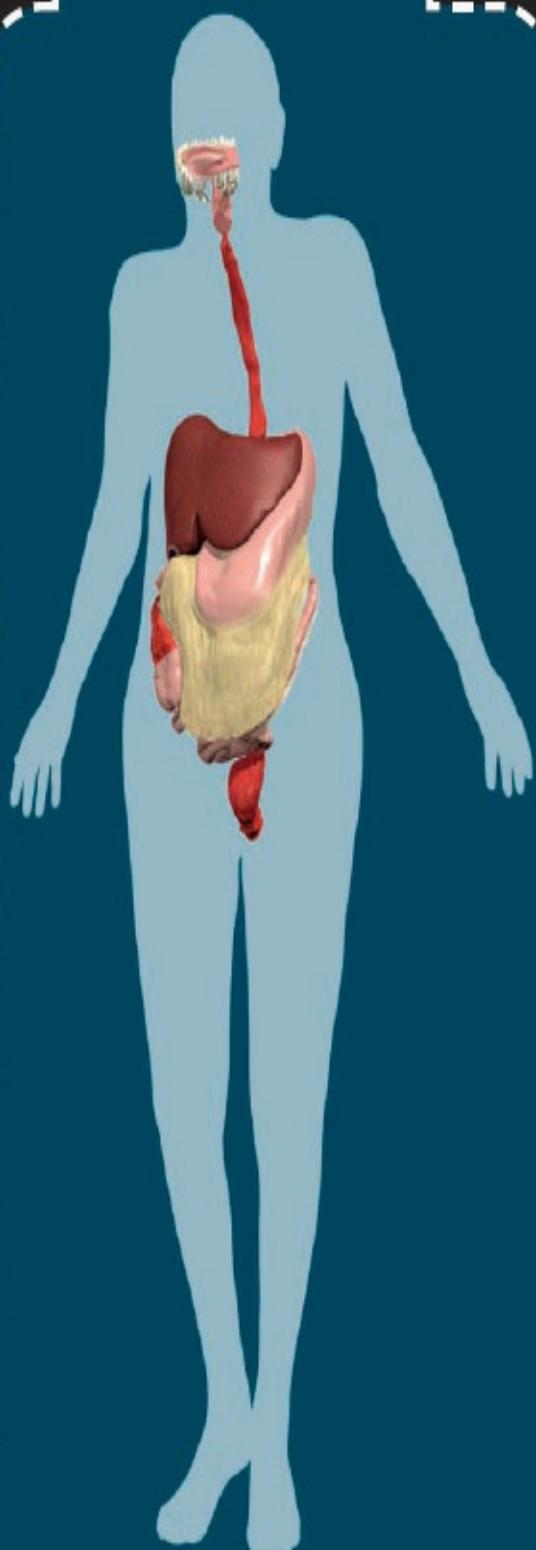
Endocrine System



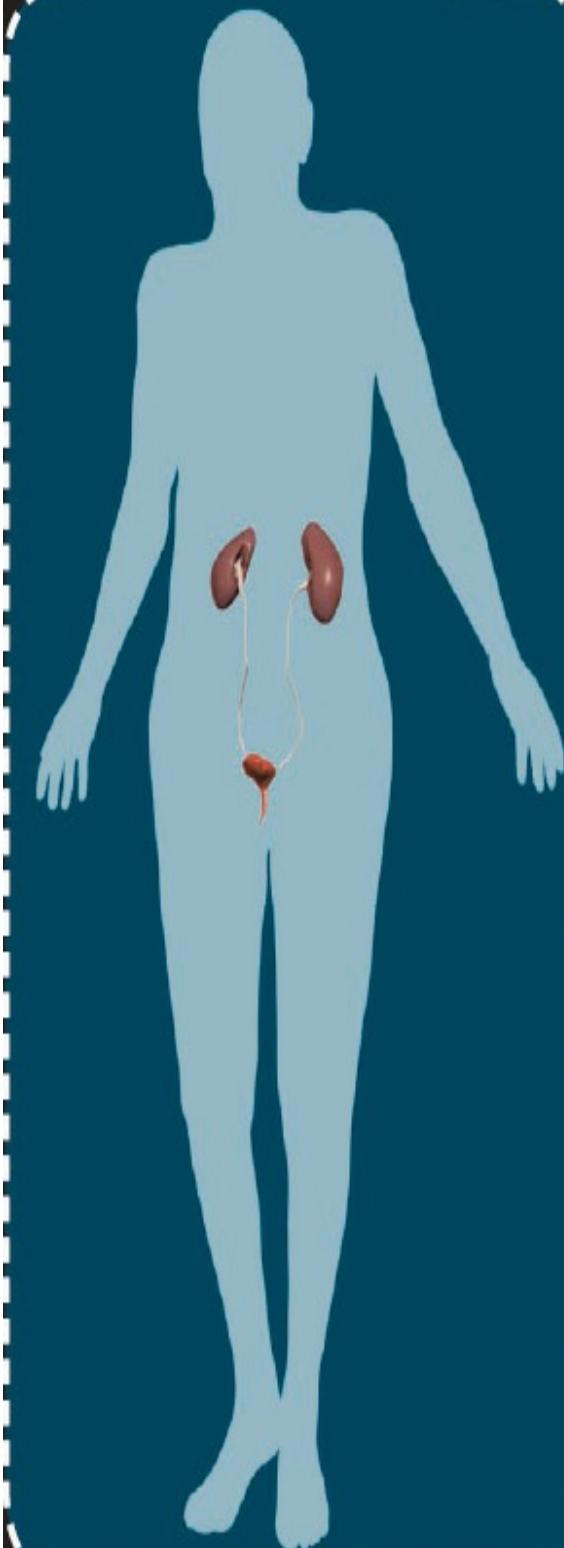
Respiratory System



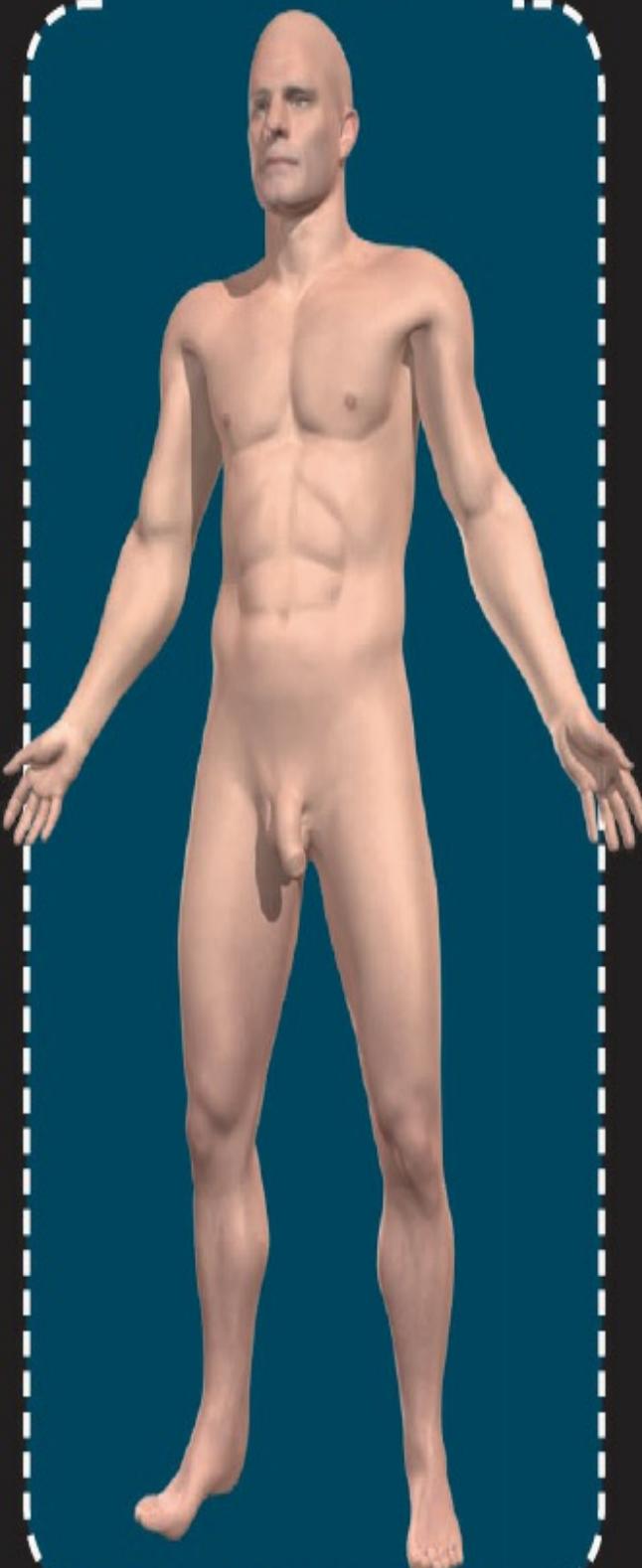
Digestive System



Urinary System

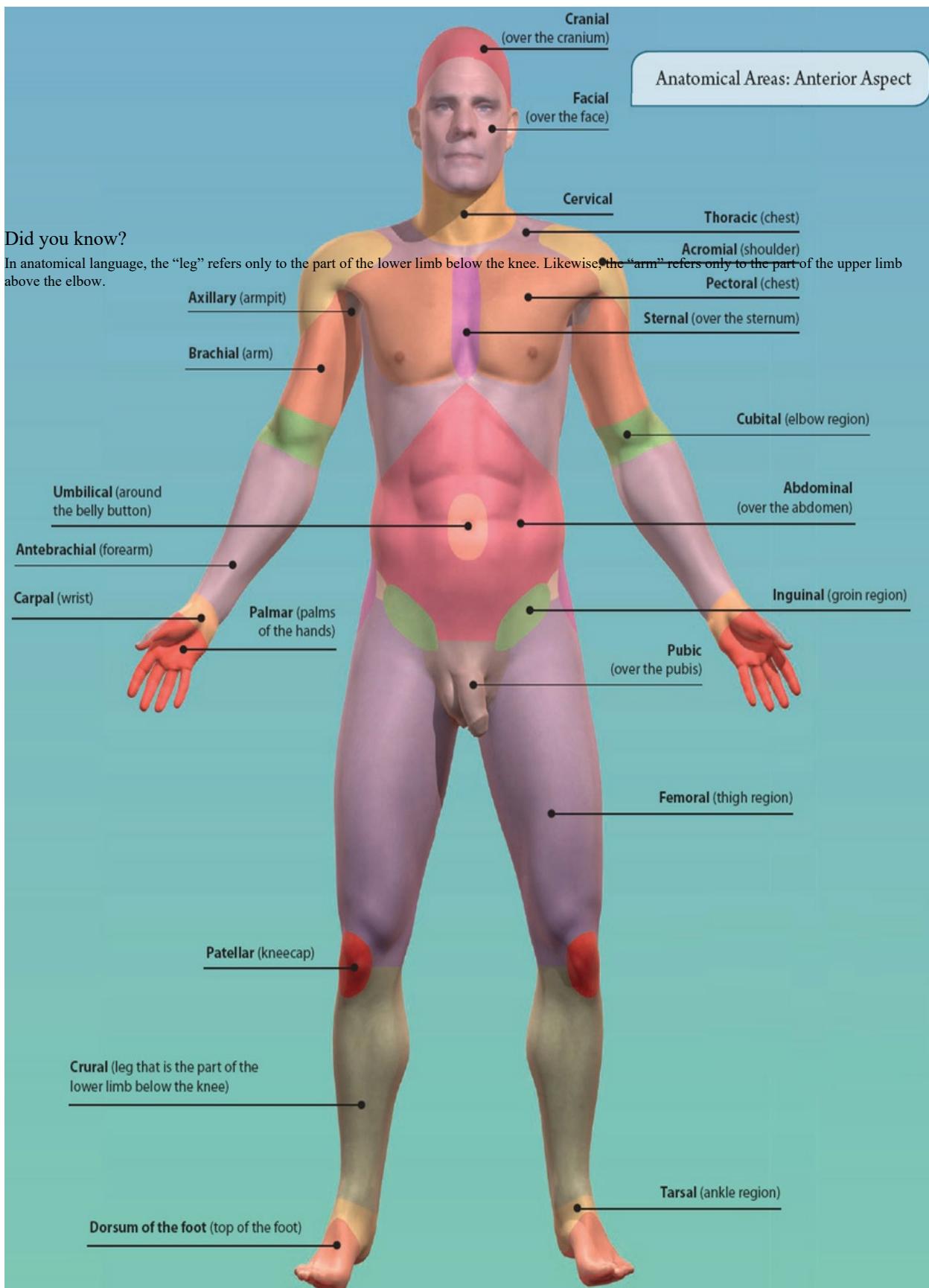


Integumentary System

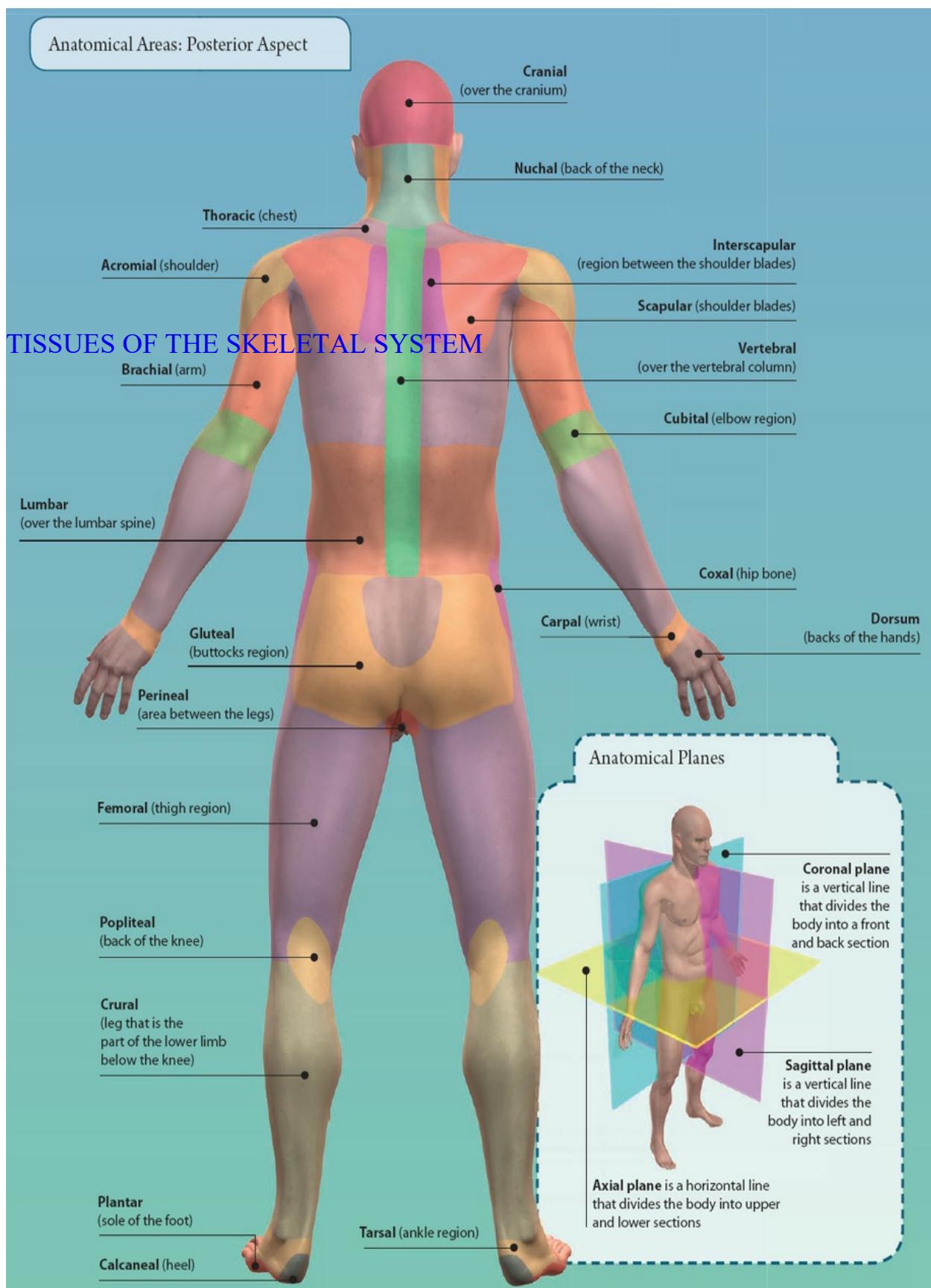


Each system is made up of a number of different organs, working together to achieve a common goal. In a similar way, all of the systems have to cooperate and work together for the human body to function properly.

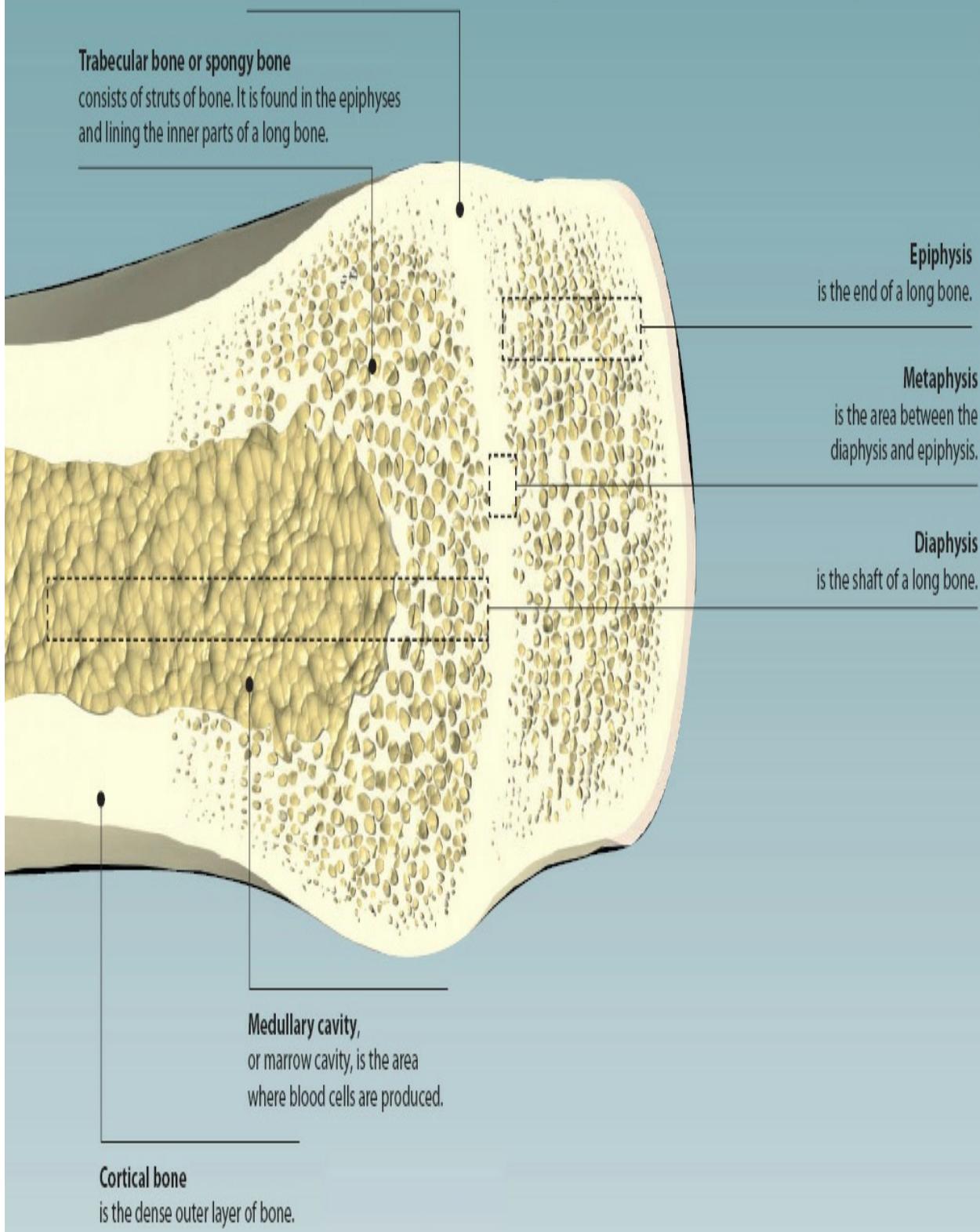
ANATOMICAL LANGUAGE

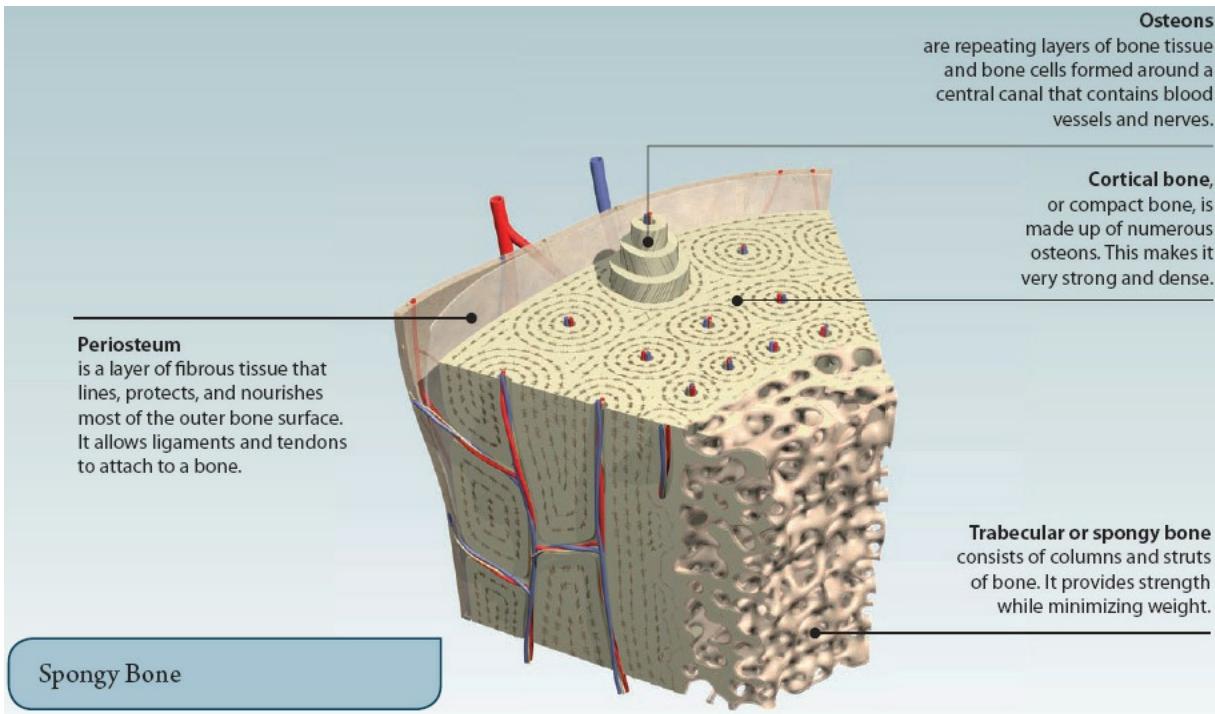


Anatomical Areas: Posterior Aspect



Anatomy of a Long Bone





Classification of Bone



Long bones,
for example thigh bones, are longer than they are wide.



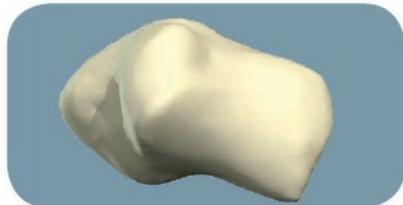
Sesamoid bones,
for example patella (kneecap), are formed inside tendons.



Irregular bones,
for example sphenoid bone of the skull, form shapes that do not fit into any of the other groups.



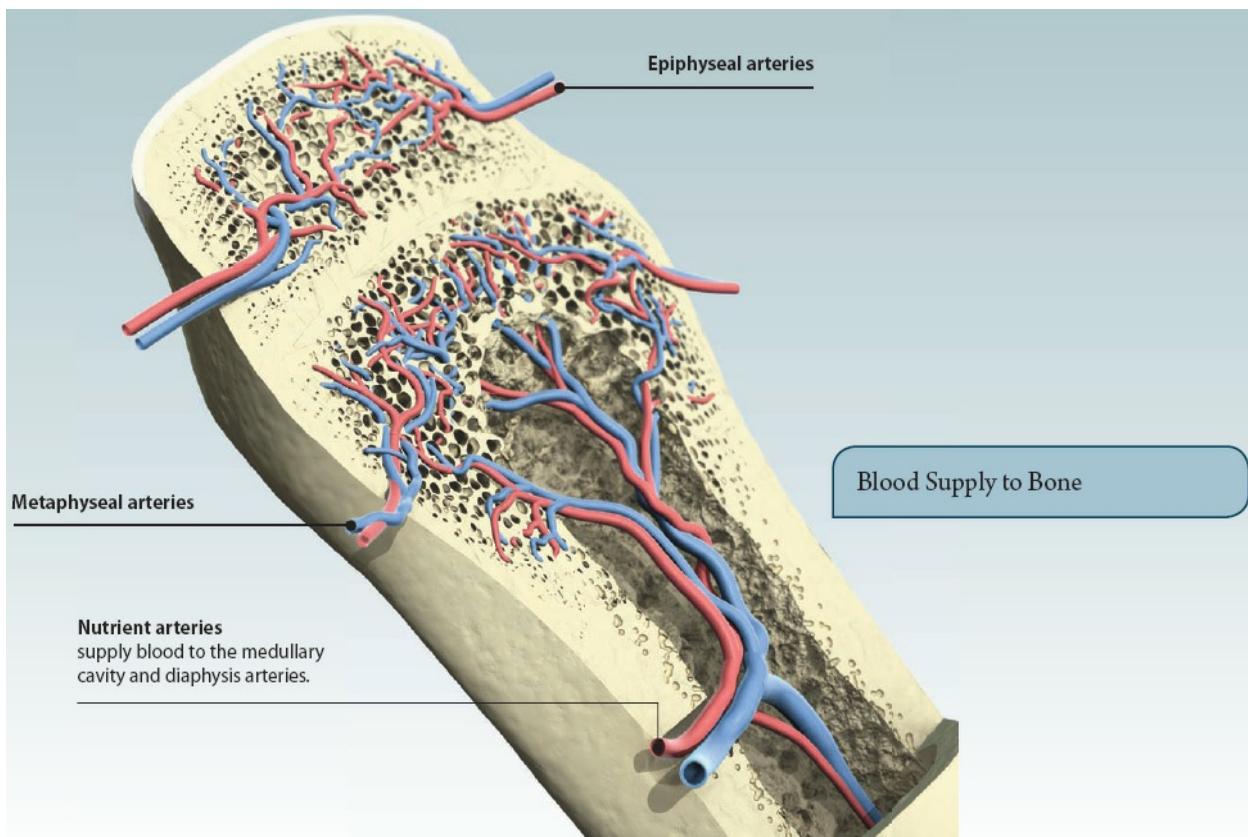
Flat bones,
for example frontal bone of the skull, form thin plates of bone.



Short bones,
for example wrist bones, tend to be equal in both length and width.

Tissues of Skeletal System

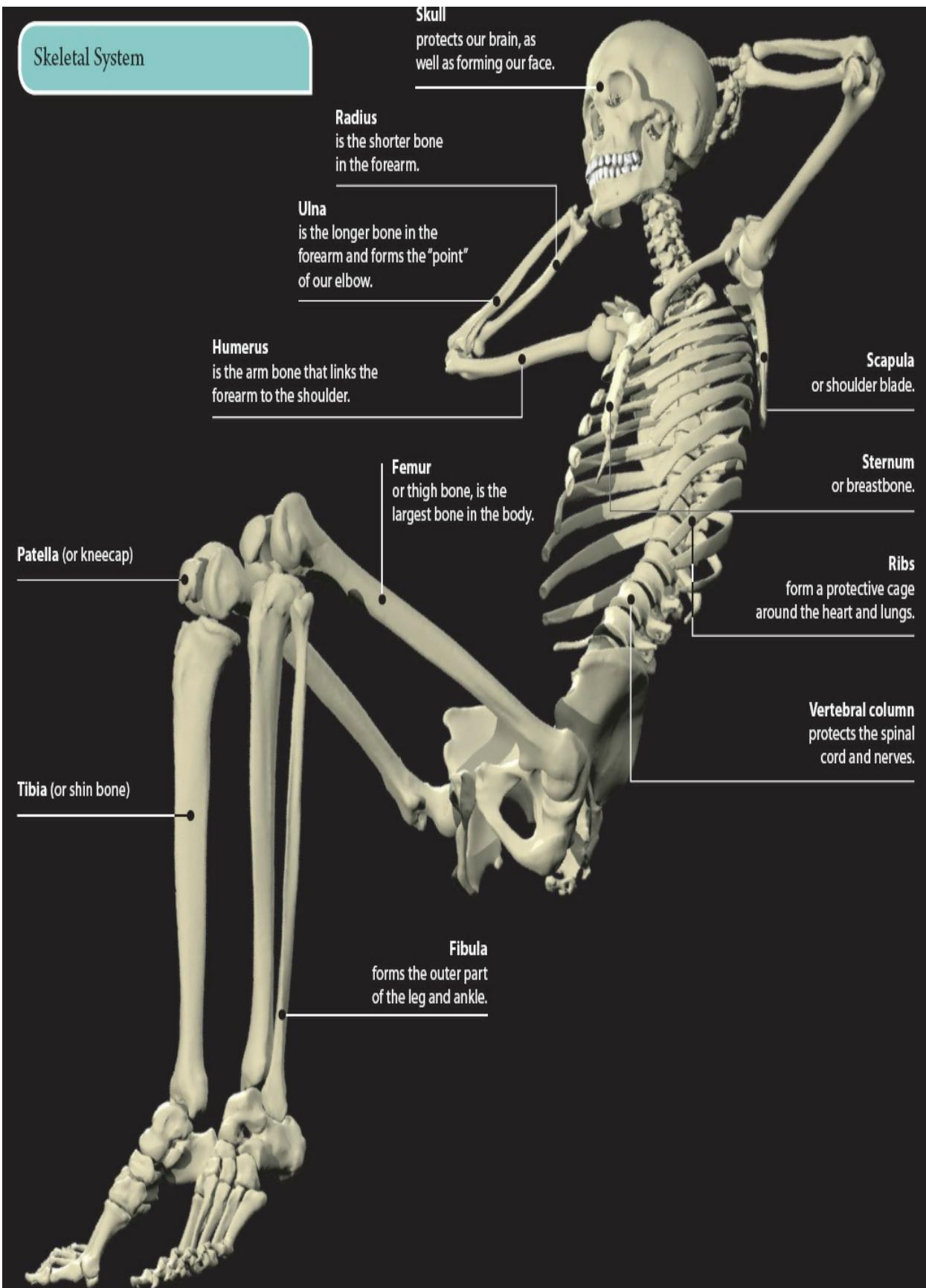
Bone is living tissue that is constantly growing and repairing itself. Old bone is broken down and new bone is formed in a process called remodeling. It is estimated that an average adult skeleton remodels about 10% of its bone each year.



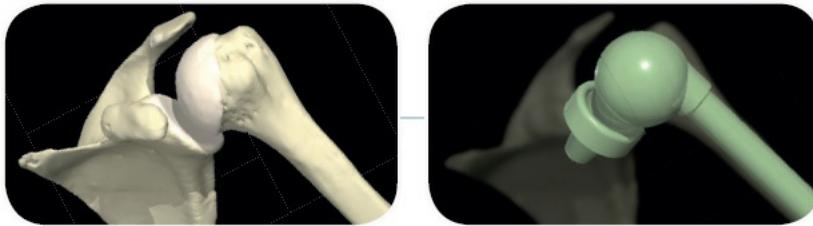
GROSS ANATOMY OF THE SKELETAL SYSTEM

The skeletal system is made up of 206 different bones. It provides a strong protective framework for the rest of the body. Joints are formed when two bones meet. There are six main types of joint that allow different ranges of movement. They are named according to the shapes of the bone surfaces that form the joint.

Skeletal System

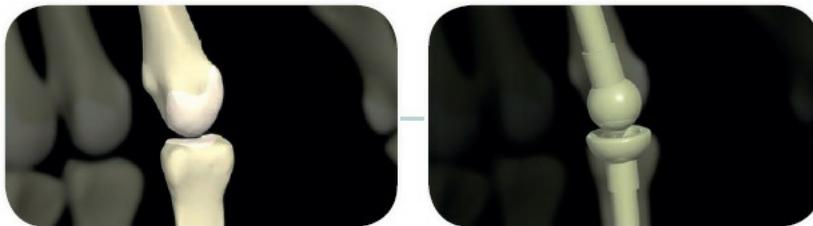


Synovial Joints



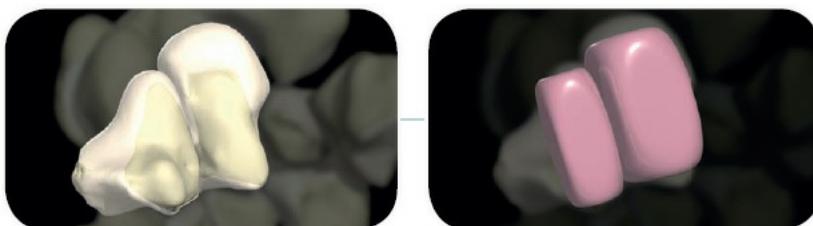
Ball and socket joints

for example shoulder, allow a wide range of movement, as the “ball” end of one bone moves freely within the “socket” of the other bone



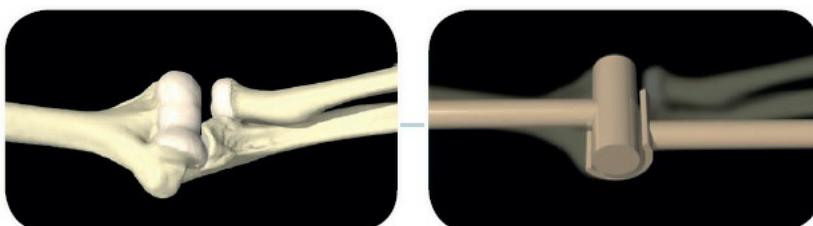
Condyloid joints

for example knuckles, consist of a rounded end of one bone moving within a shallow depression on the other bone.



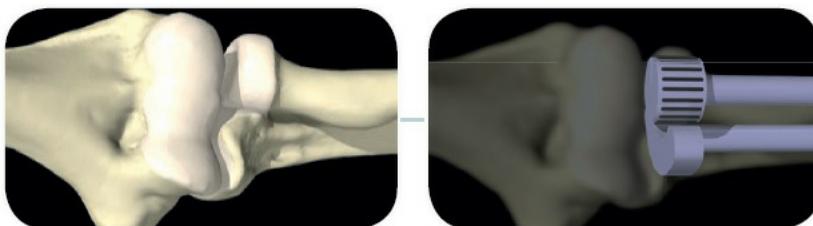
Gliding joints

for example wrist, have two flat bone surfaces moving past each other.



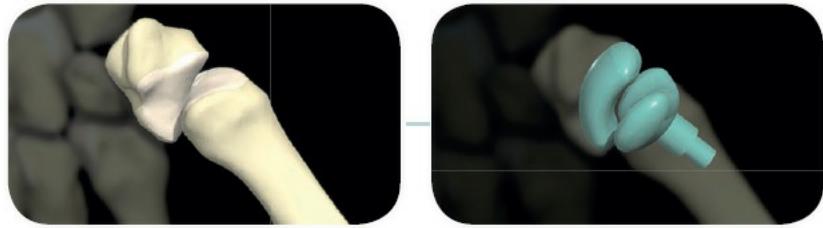
Hinge joints

for example elbow, only allow movement in one plane, such as bending and straightening.



Pivot joints

for example forearm, allow rotational movements to take place.



Saddle joint

for example thumb, allows movements in a number of different directions due to the shape of the bone surfaces.

TISSUES OF THE MUSCULAR SYSTEM

The main role of the muscular system is to produce movement. It does this through specialized muscle cells that are able to contract and alter their length. There are three main types of muscle tissue: skeletal, smooth, and cardiac. Skeletal muscle is attached to the skeletal system via tendons. It is under voluntary control. Smooth and cardiac muscle are termed involuntary muscles, as their contractions can occur without conscious control. Smooth muscle is mainly located within the walls of the internal organs. Cardiac muscle is found in the heart.

Smooth muscle

Smooth muscle helps control the size of internal organ passageways and the movement of substances through them.

Nucleus

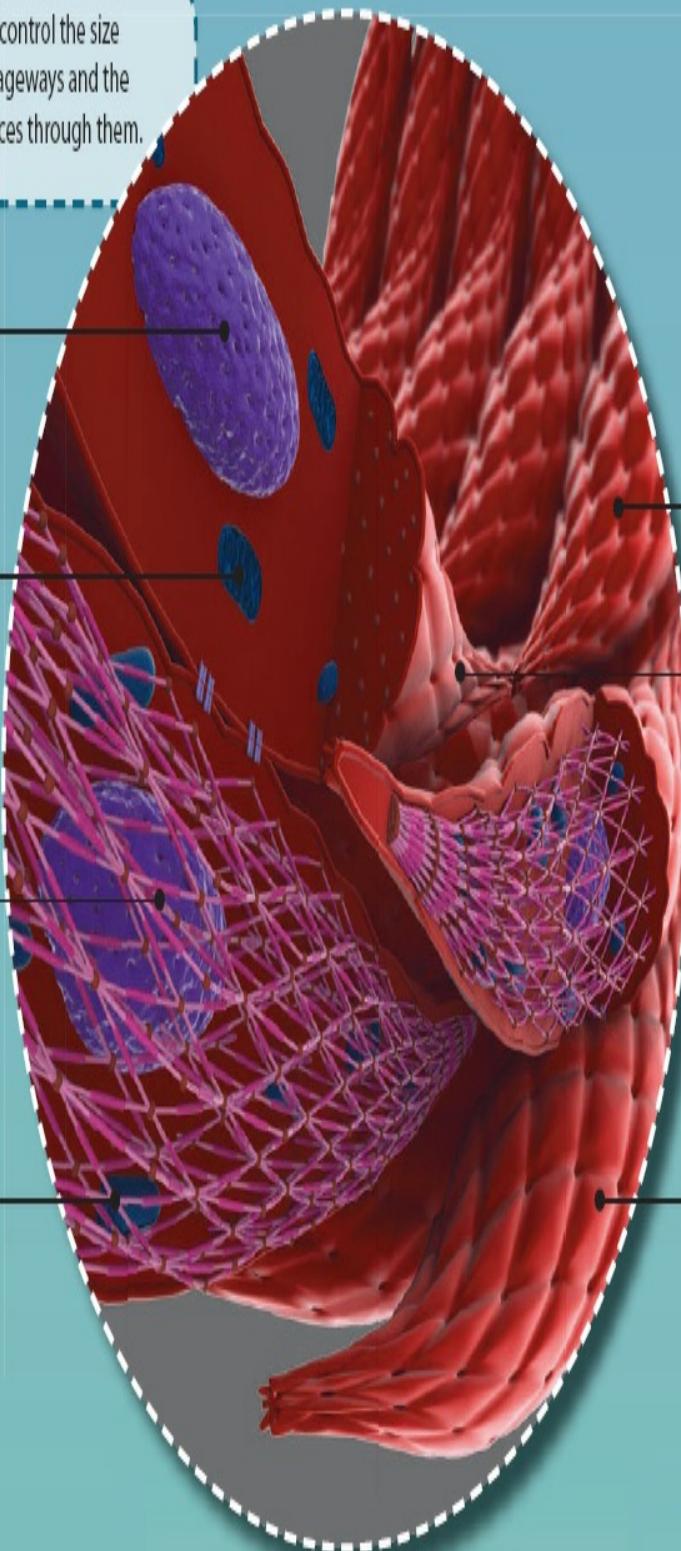
Mitochondria produce energy for muscle contraction.

Contractile filaments produce shortening of each smooth muscle cell.

Dense bodies are points of attachment for parts of the contractile filaments.

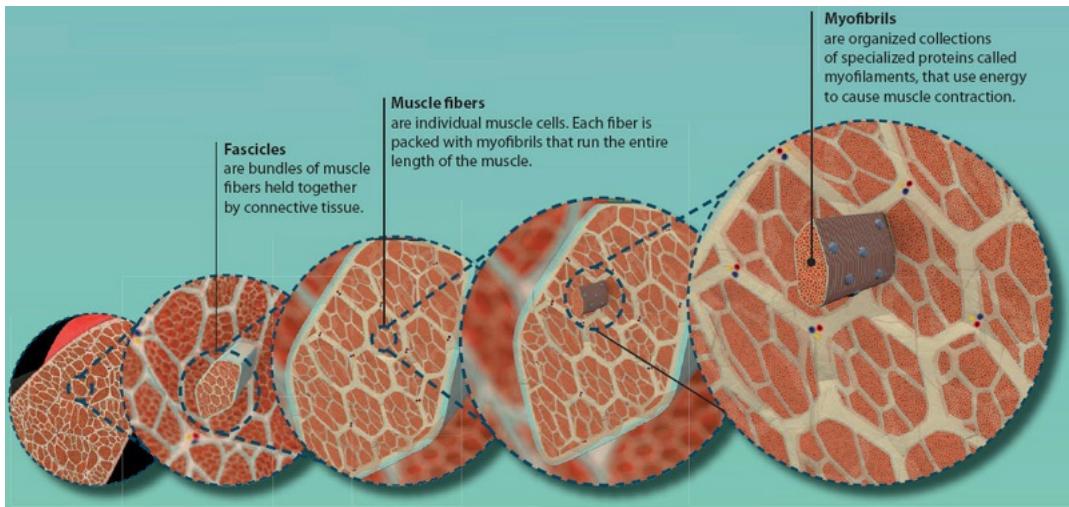
Smooth muscle cells

are spindle shaped and form close connections with surrounding cells.



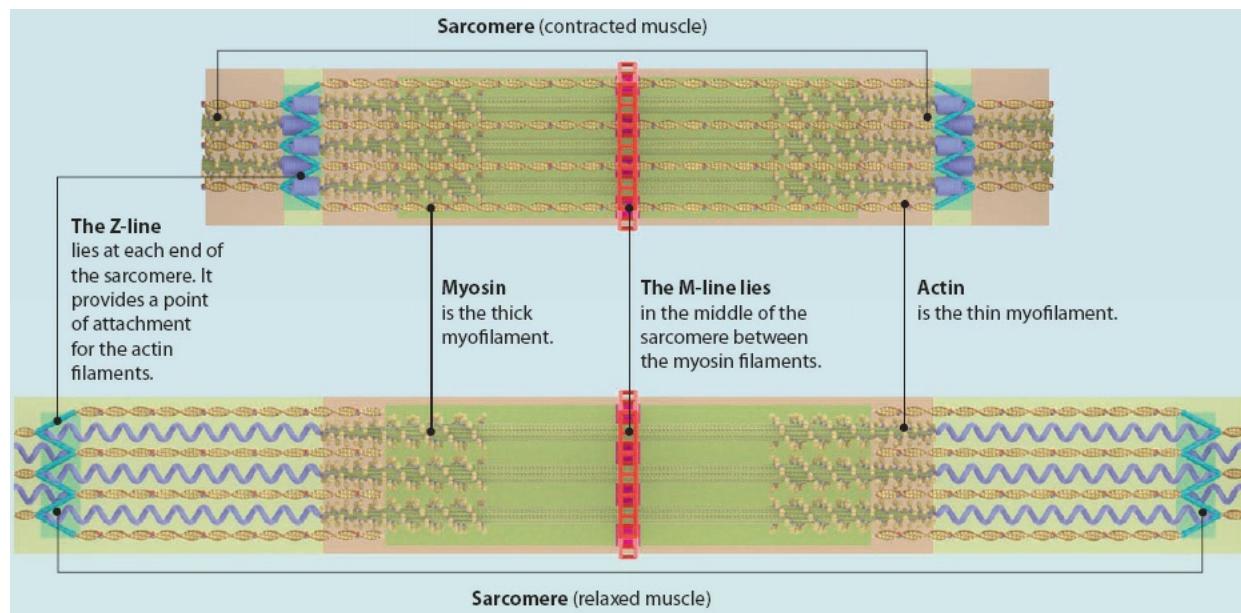
Skeletal muscle

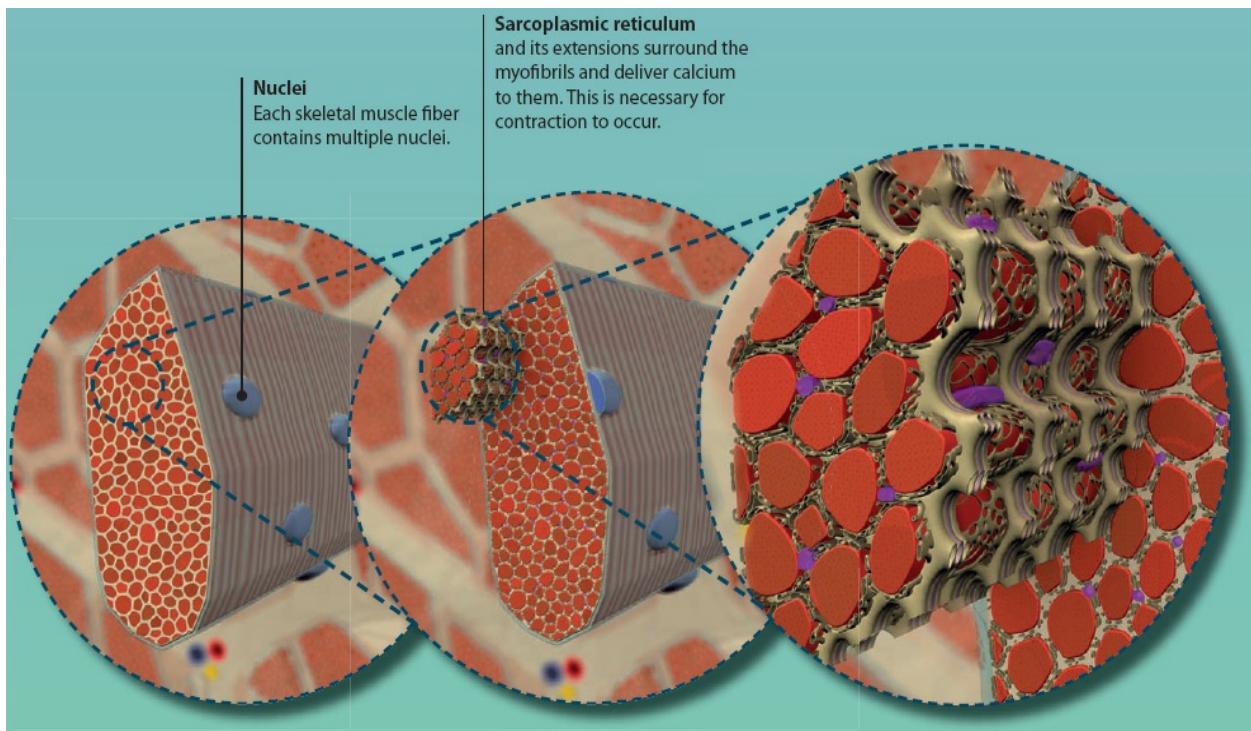
Skeletal muscle has a highly organized structure.



Sarcomere

Sarcomeres are regular repeating divisions of the myofibrils. The myofilaments within each sarcomere use energy to slide past each other, causing shortening of the entire muscle (contraction).

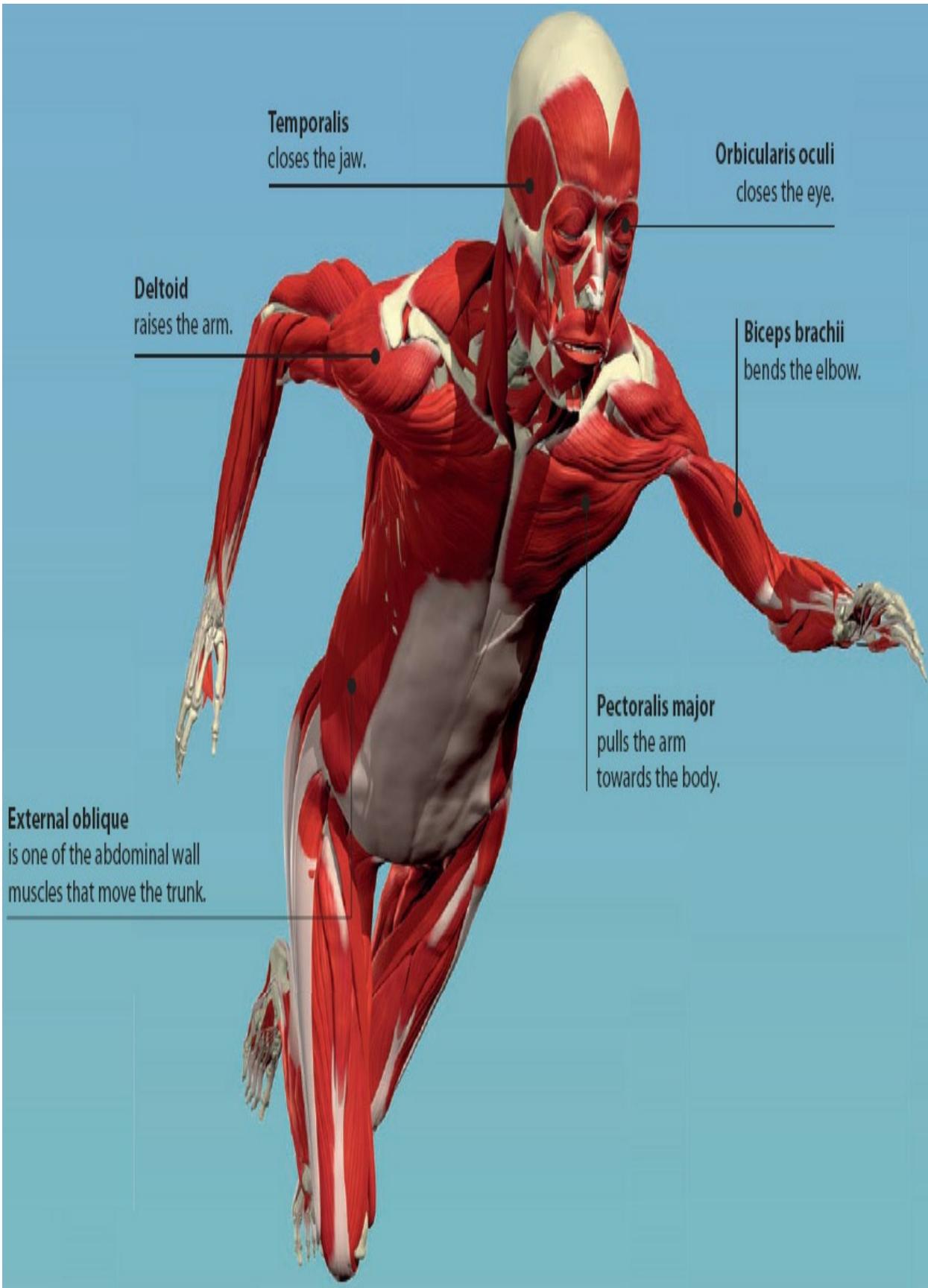




GROSS ANATOMY OF THE MUSCULAR SYSTEM

There are over 600 muscles in the human body. Working together they allow us to run and jump, to skip and dance, to eat and speak. Skeletal muscles come in various shapes and sizes, and can be grouped according to the way in which their fibers are organized. Muscles are connected to bones by tough fibrous tissue called tendons.





Classification of Muscles



Fusiform muscles

have thick muscle bellies that taper to form one or more tendons, for example biceps brachii.



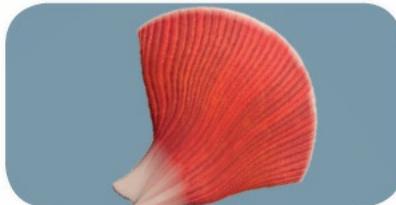
Parallel muscles

have muscle fibers that run straight from one end of the muscle to the other, for example external oblique.



Circular muscles

are found around an opening, and are able to close it when they contract, for example orbicularis oculi.



Triangular muscles

have fibers that come from many directions before meeting on a single tendon, for example temporalis.



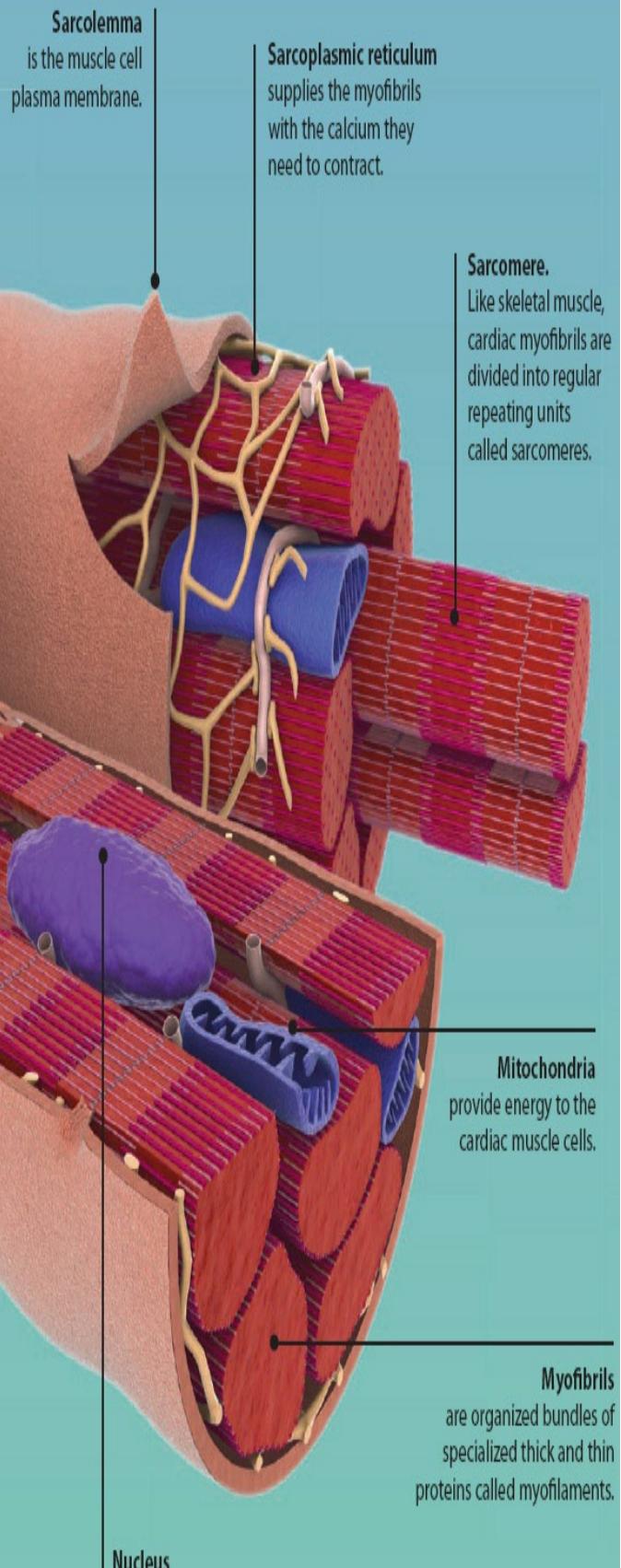
Pennate muscles

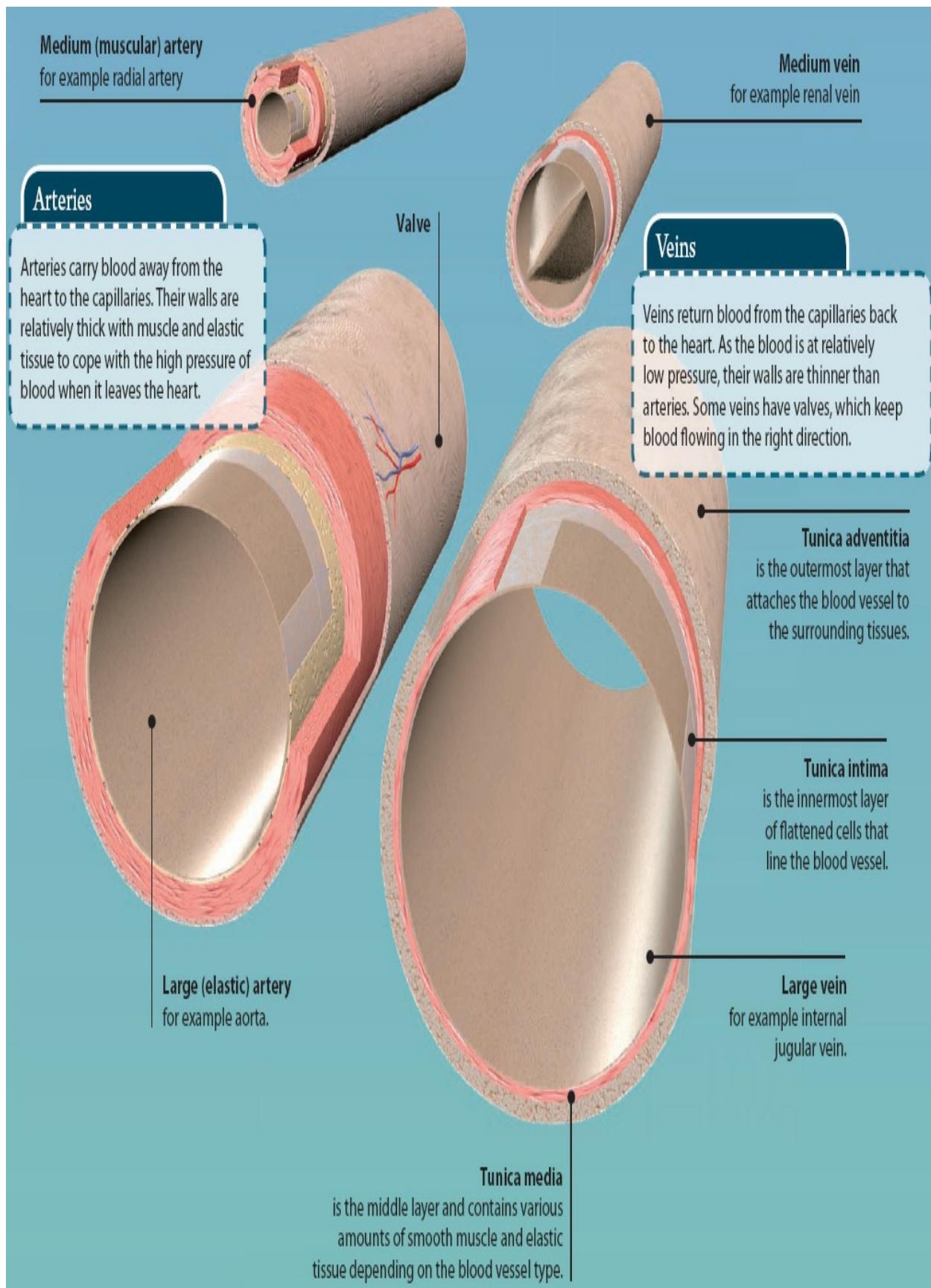
have a central tendon to which fibers attach at various angles, similar to a birds feather, for example deltoid.

TISSUES OF THE CARDIOVASCULAR SYSTEM

The cardiovascular system is made up of the heart and blood vessels. Together, they provide a constant supply of oxygen and nutrient-rich blood to all the tissues of the body, while removing any waste products. The heart is a muscular organ made up of specialized cardiac muscle tissue. It pumps blood around the body's blood vessels, of which there are three main types: arteries, capillaries, and veins.

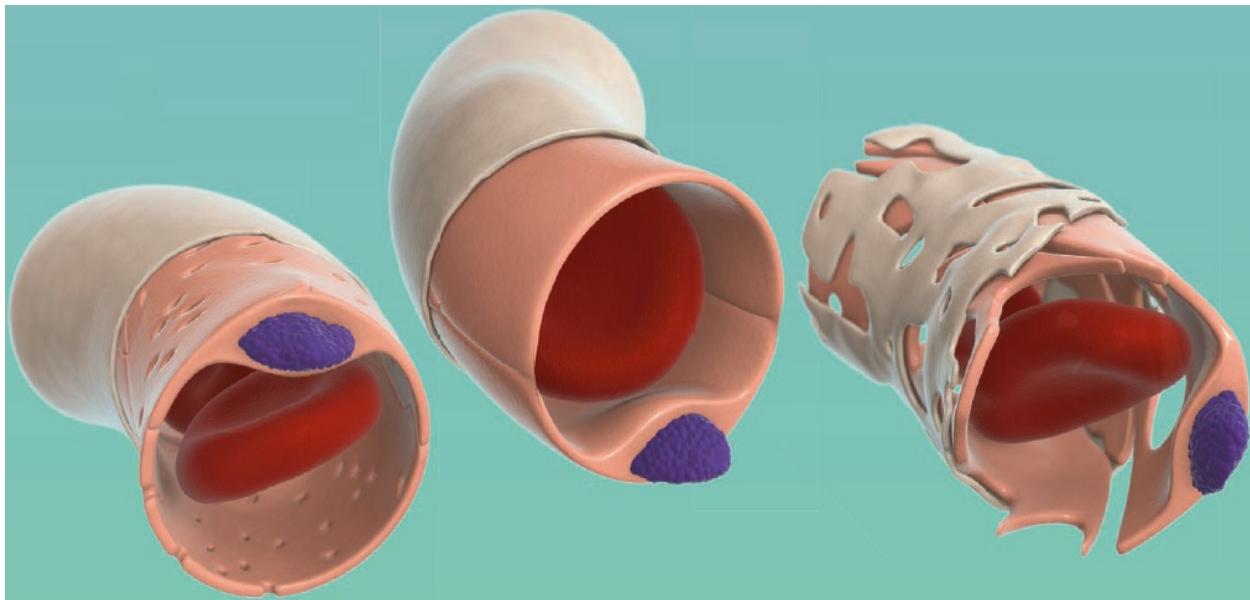
Cardiac Muscle





Capillaries

Capillaries are the smallest blood vessels. Their thin walls allow substances to easily move between the tissues and the blood.

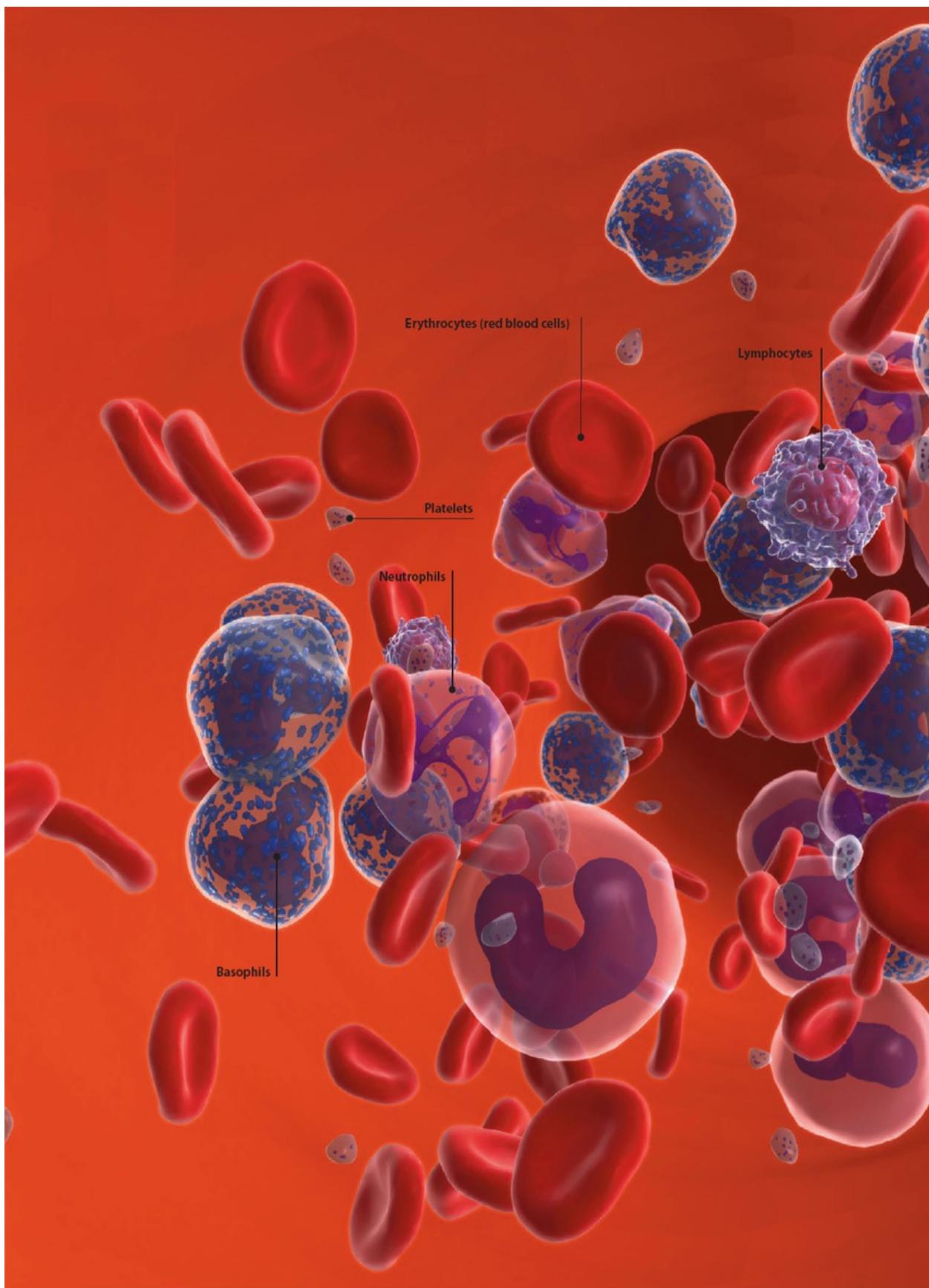


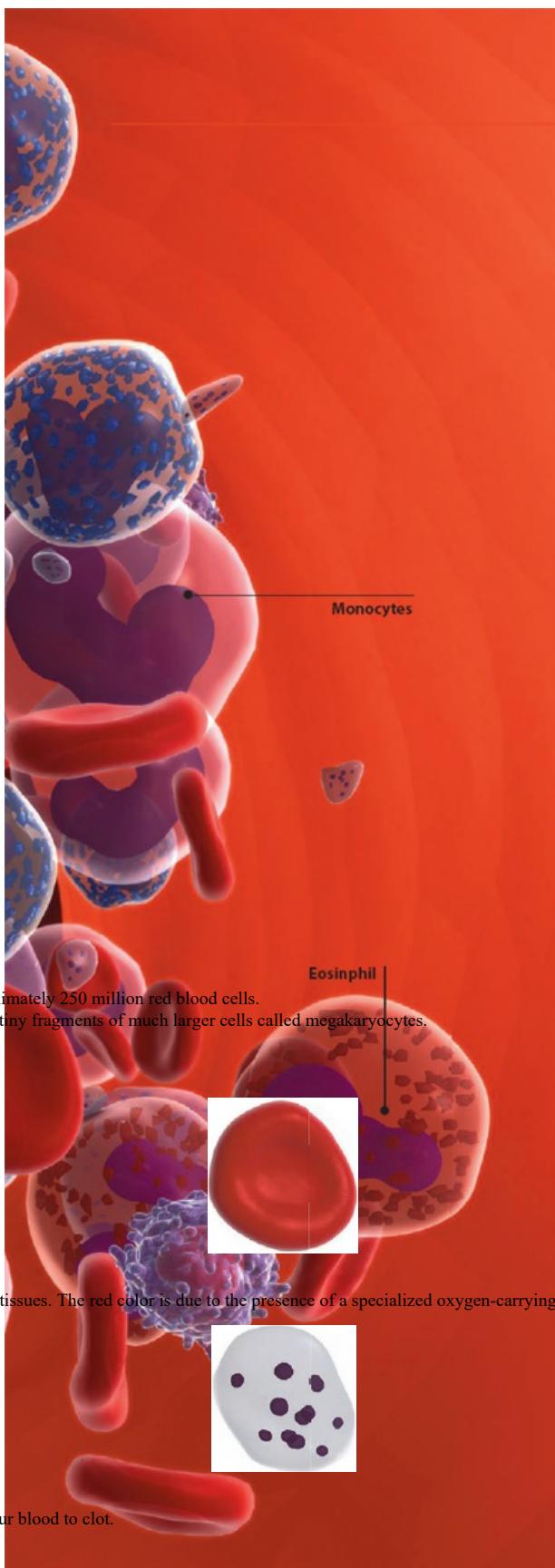
BLOOD

Blood is a living liquid made up of cells and fluid. It is pumped around the blood vessels by the heart. Its main role is to deliver oxygen and nutrients to the tissues of the body, and carry waste products away.

The fluid part of blood is called plasma. It contains proteins, salts, and nutrients.

There are different types of cells in the blood. Red cells carry oxygen to the tissues; white cells fight infection; and platelets help to form clots. They are all produced in the bone marrow.





Did you know?

A single drop of blood contains approximately 250 million red blood cells.

Platelets are not cells. Instead they are tiny fragments of much larger cells called megakaryocytes.

Formed Elements of Blood

Erythrocytes (red blood cells)

transport oxygen from the lungs to the tissues. The red color is due to the presence of a specialized oxygen-carrying protein called hemoglobin.

Platelets

are small fragments of cells that help our blood to clot.



Lymphocytes

are white blood cells that can fight a wide range of infectious organisms. There are three types of lymphocyte: B-cells, T-cells, and natural killer (NK) cells.



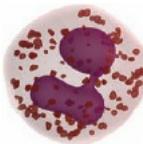
Monocytes

are white blood cells that can move into the tissues, where they are called macrophages. They remove cell debris and infectious organisms by engulfing them—a process known as phagocytosis.



Neutrophils

are the most common white blood cell. They have irregularly shaped nuclei. Their granules contain substances used to kill infectious organisms.



Eosinophil

is a type of white blood cell particularly involved in fighting parasite infections.

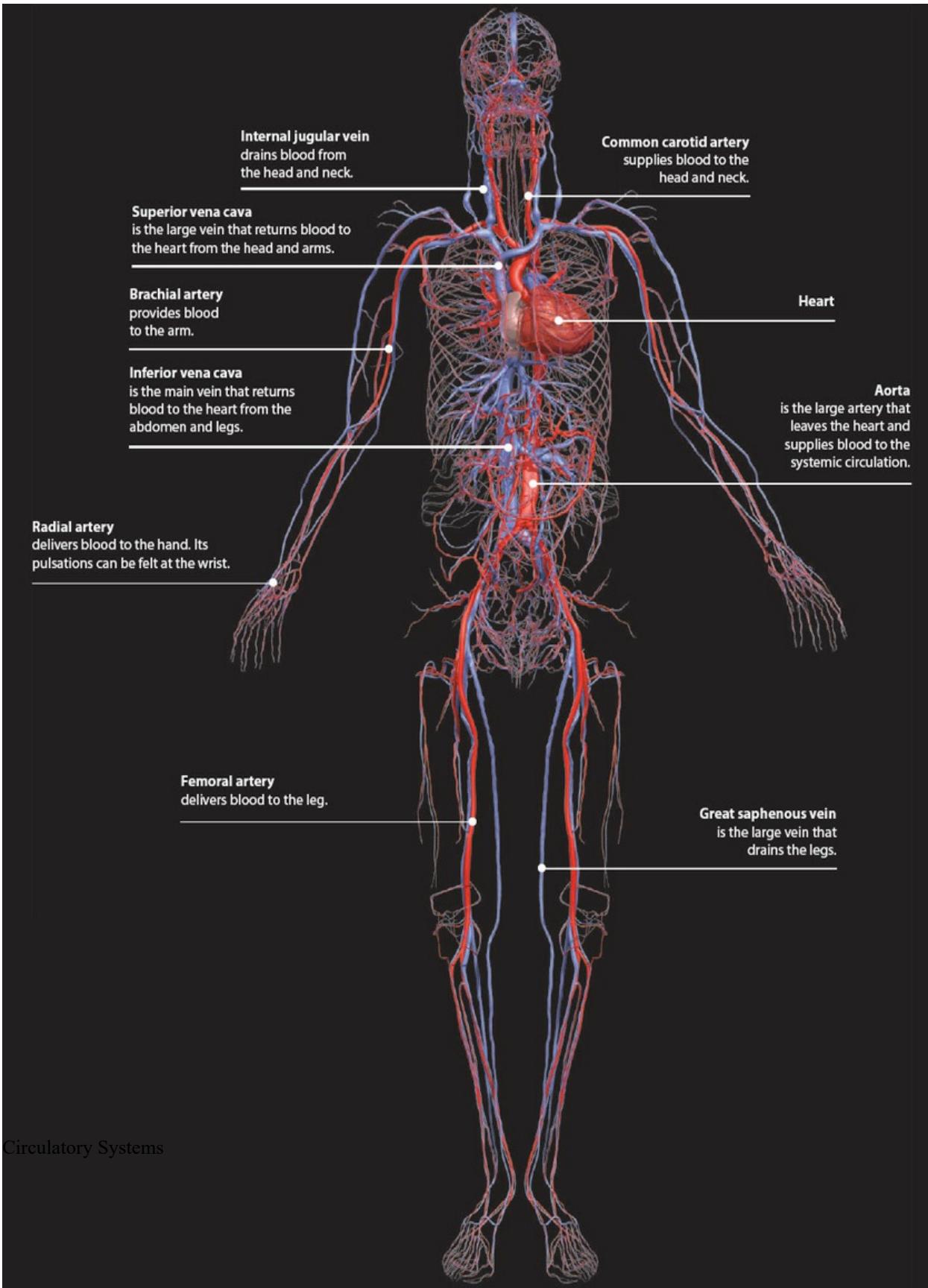


Basophils

are the least abundant white blood cells. Their granules contain substances that cause inflammation when released.

GROSS ANATOMY OF THE CARDIOVASCULAR SYSTEM

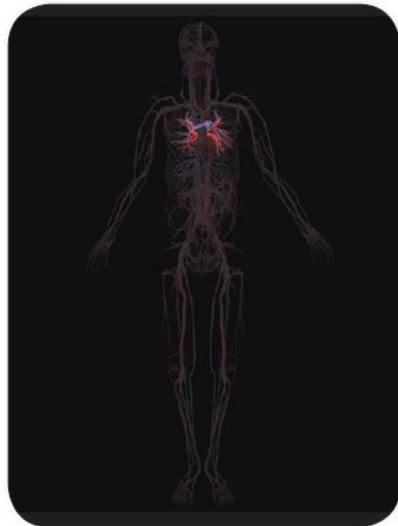
The tissues of the body require a constant supply of blood. This provides them with the oxygen and nutrients they need to survive, and also removes their waste products. The delivery and removal of blood is performed by the cardiovascular system. The heart pumps blood to the tissues of the body through a network of vessels. There are two main blood vessel circuits—the systemic and pulmonary circulations.



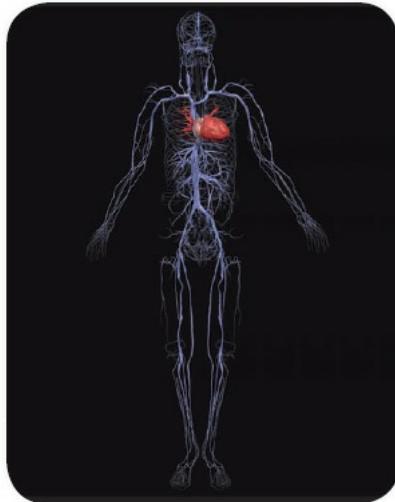
Circulatory Systems

**Arteries**

carry blood away from the heart.

**Pulmonary Circulation**

carries blood from the heart to the lungs, before returning it to the heart. In the lungs, oxygen is added to the blood and carbon dioxide removed.

**Veins**

carry blood back to the heart.

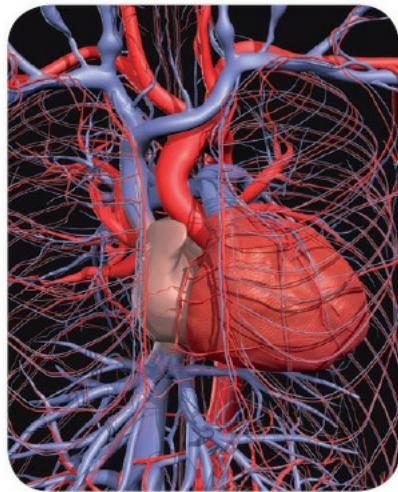
**Portal Circulation**

vessels carry nutrient rich blood from the gut for processing in the liver.



Systemic Circulation

carries blood from the heart to the tissues of the body, before returning it to the heart. In the tissues, oxygen is removed from the blood and carbon dioxide added.

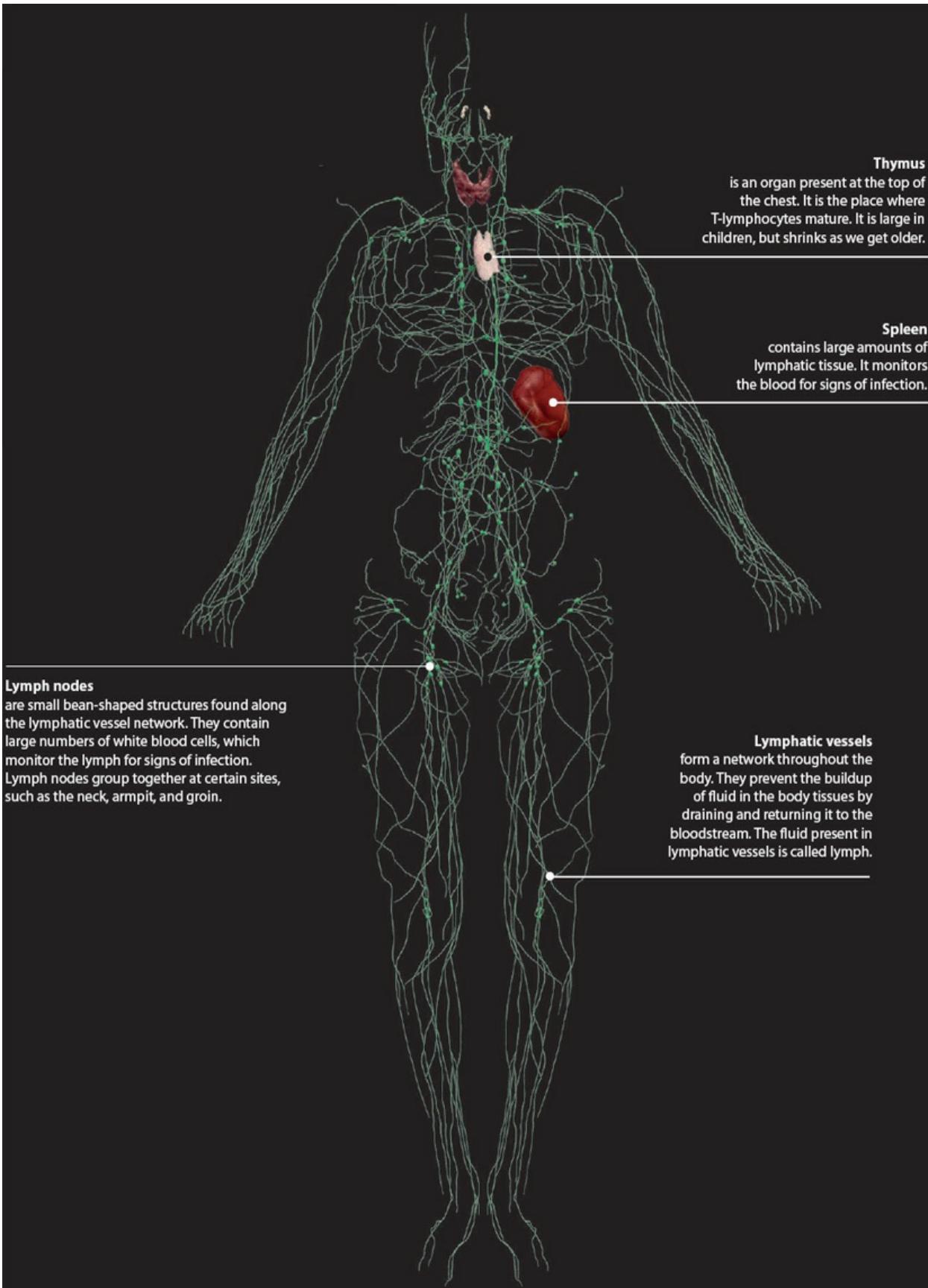


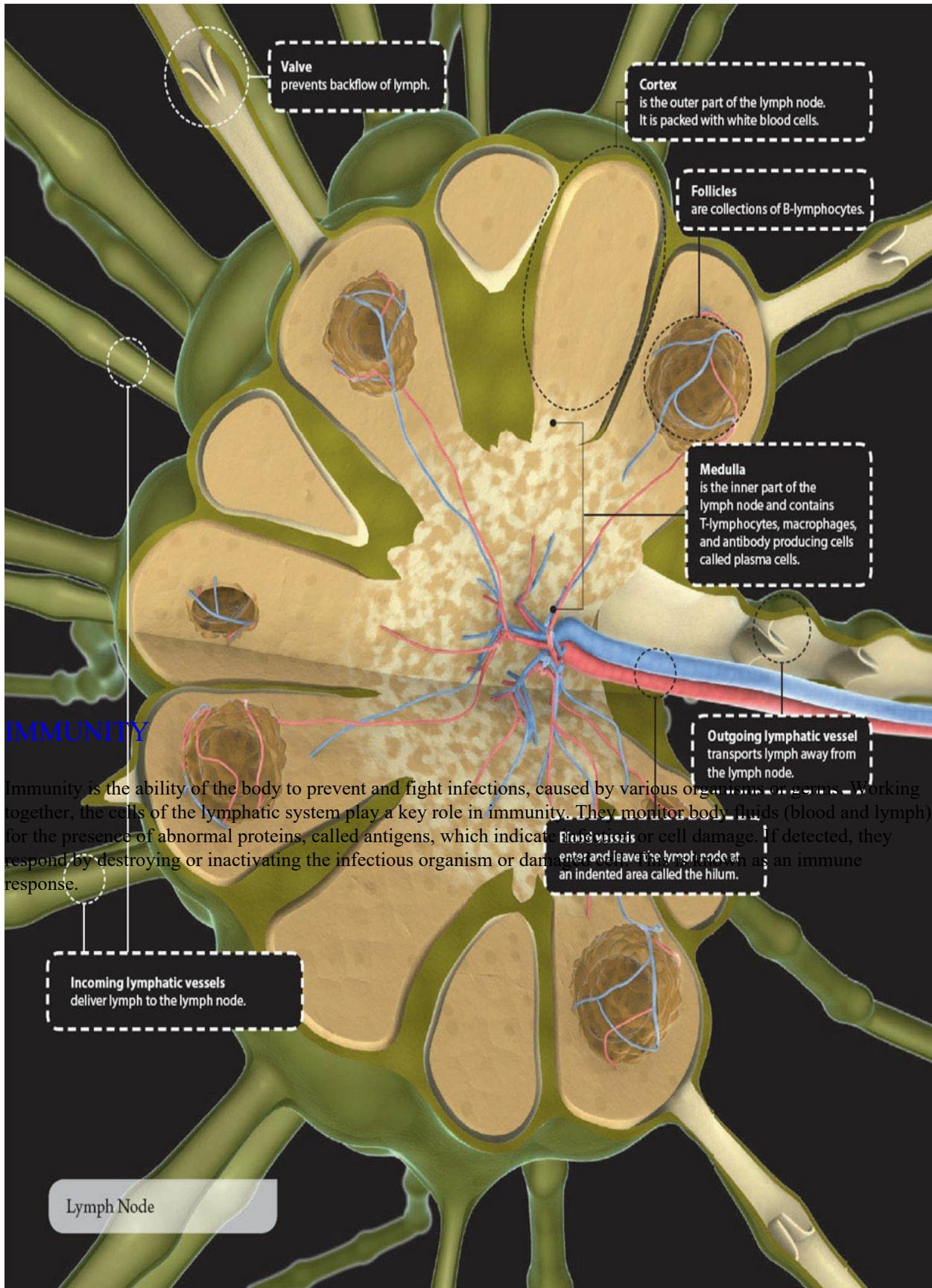
Heart

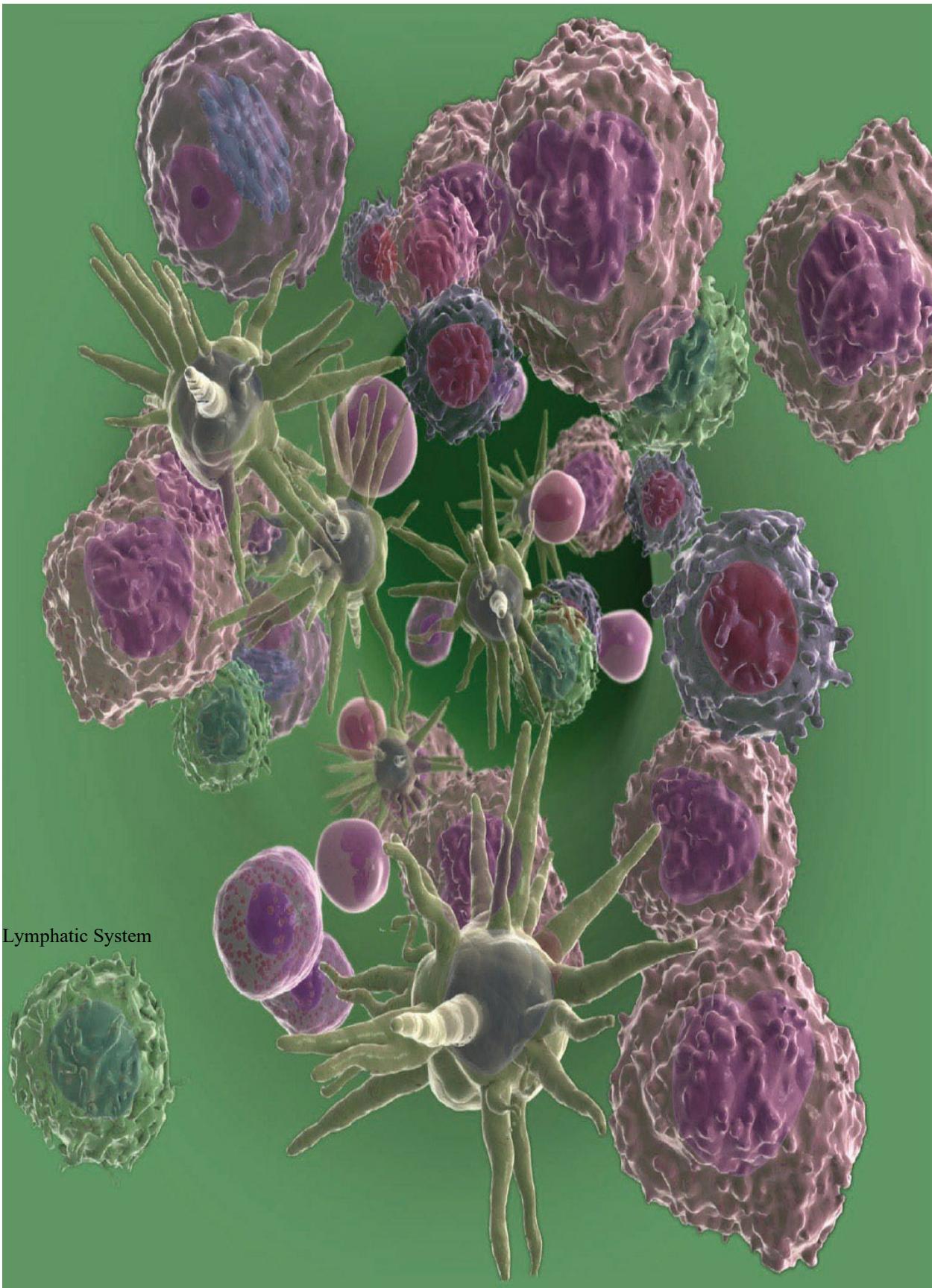
is a muscular organ which pumps blood around the network of blood vessels.

LYMPHATIC SYSTEM

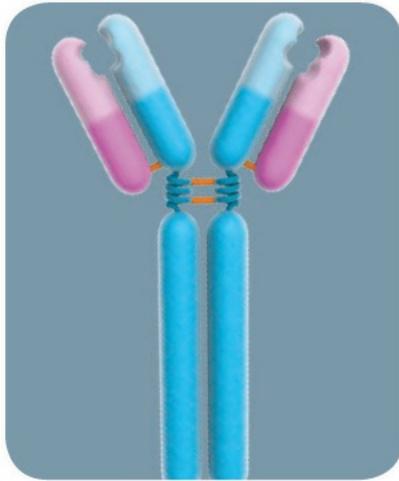
The lymphatic system has two main roles: to drain excess tissue fluid, and to fight infection. It consists of a network of lymphatic vessels, along with organs that make or contain large amounts of lymphatic tissue. These include the bone marrow, thymus, lymph nodes, and spleen. Lymphatic tissue is formed from collections of white blood cells, particularly lymphocytes and macrophages.





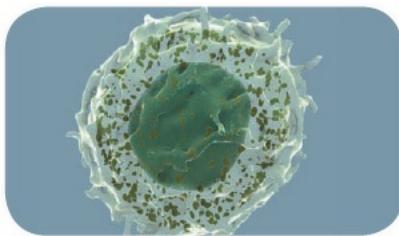


Lymphatic System



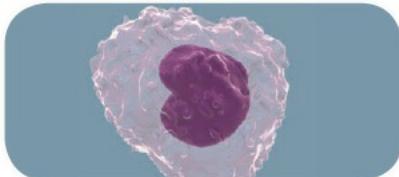
Antibodies

are special proteins produced by plasma cells. They attach to antigens on infectious organisms, inactivating them, or marking them for destruction.



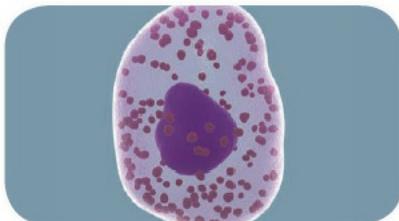
Natural killer (NK) cells

cells are able to recognize and destroy damaged or infected body cells. They do this by releasing granules containing toxic substances.



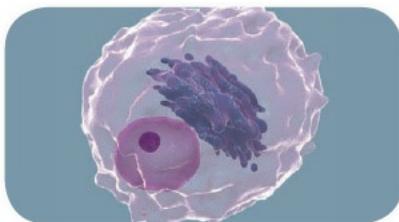
Macrophages

are able to engulf and “eat” cell debris and infectious organisms that have been marked for destruction. This process is known as phagocytosis.



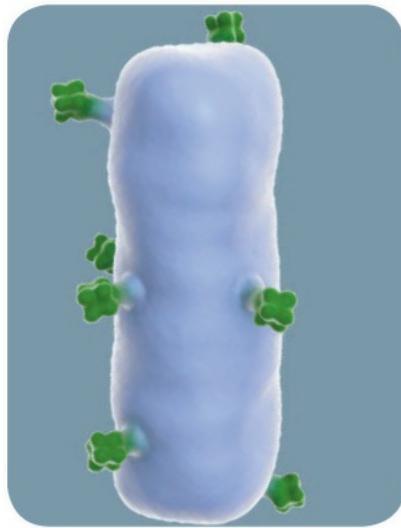
Mast cells

are similar to basophils. They contain granules which when released cause inflammation and attract other cells to an area.



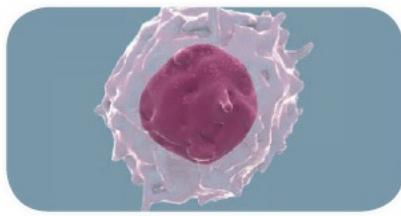
Plasma cells

are antibody producing cells. They are formed from B-cells.



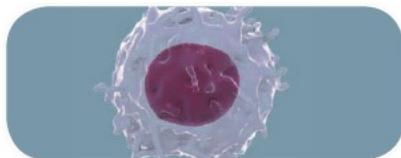
Antigens

are proteins present on the surface of an infectious organism. Cells of the lymphatic system recognize these as “foreign,” and mount an immune response.



B-cells

are lymphocytes that can form plasma cells and antibodies when they recognize a specific antigen.



T-cells

are lymphocytes that can destroy infected cells when they recognize a specific antigen. They also coordinate the immune response by producing special chemical signals that tell other cells what to do.

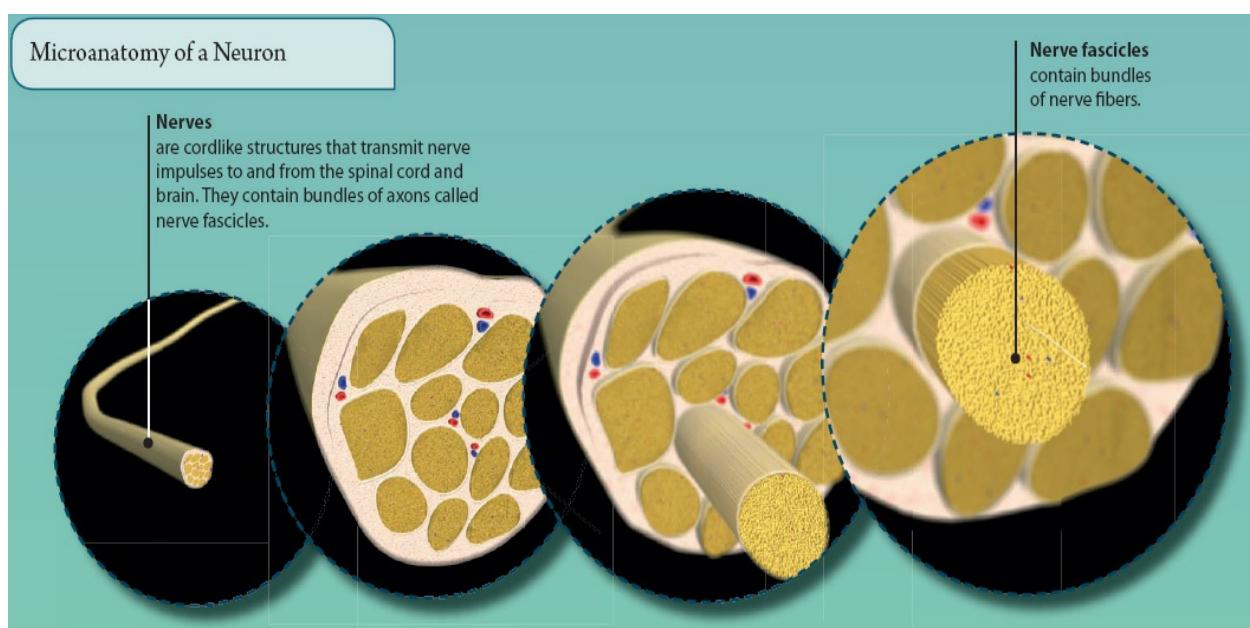
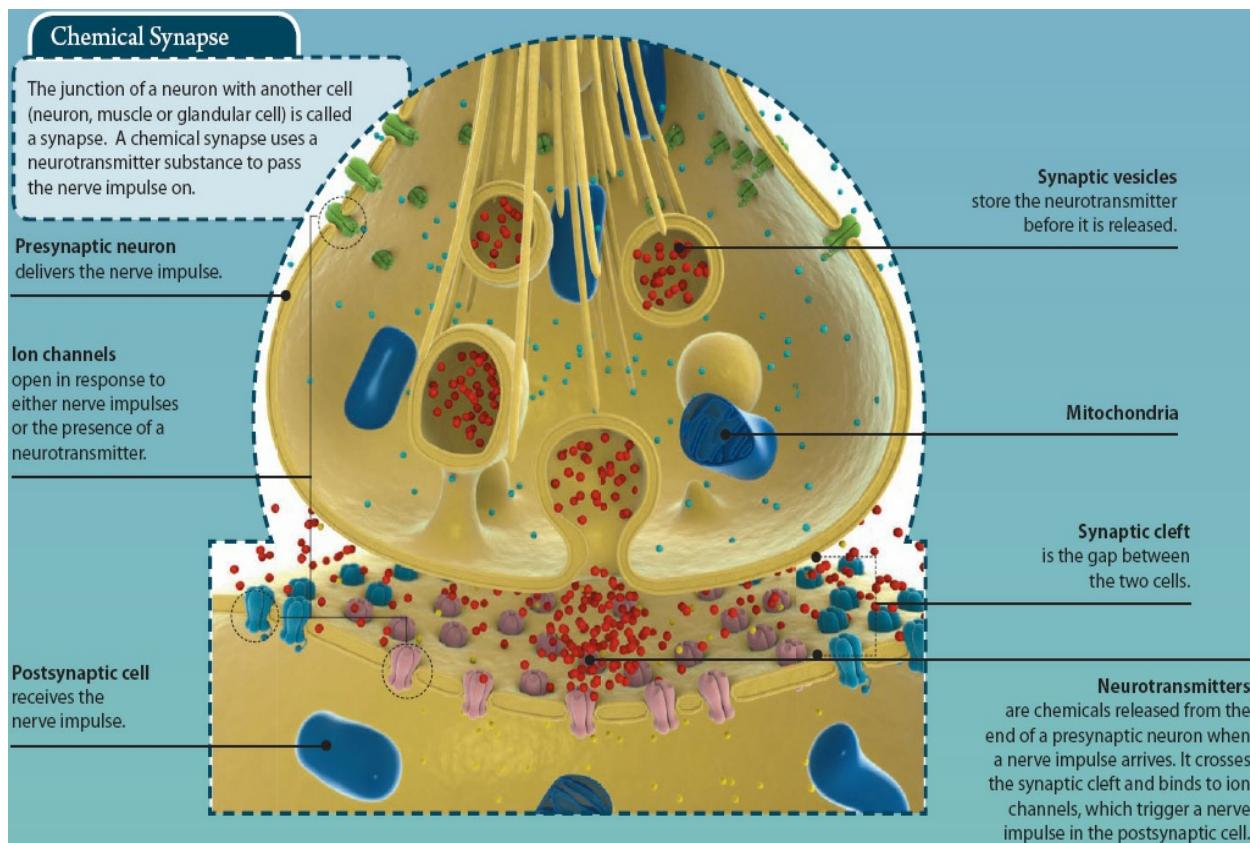


Dendritic cells

process the proteins present in lymph. Their long “arms” hold them so that other cells can sample them.

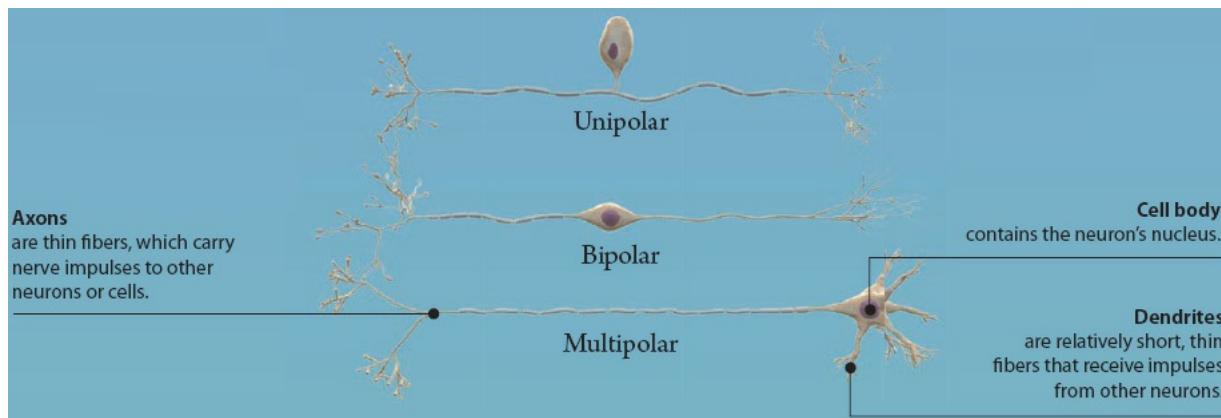
TISSUES OF THE NERVOUS SYSTEM

The nervous system consists of the brain, spinal cord, and nerves. It allows us to see, hear, smell, taste, touch, move, feel, remember, and much more. To do all this requires the rapid, coordinated transmission of multiple signals, between different parts of the body. This is possible through the billions of specialized nerve cells (neurons) that conduct electrical signals, known as nerve impulses.

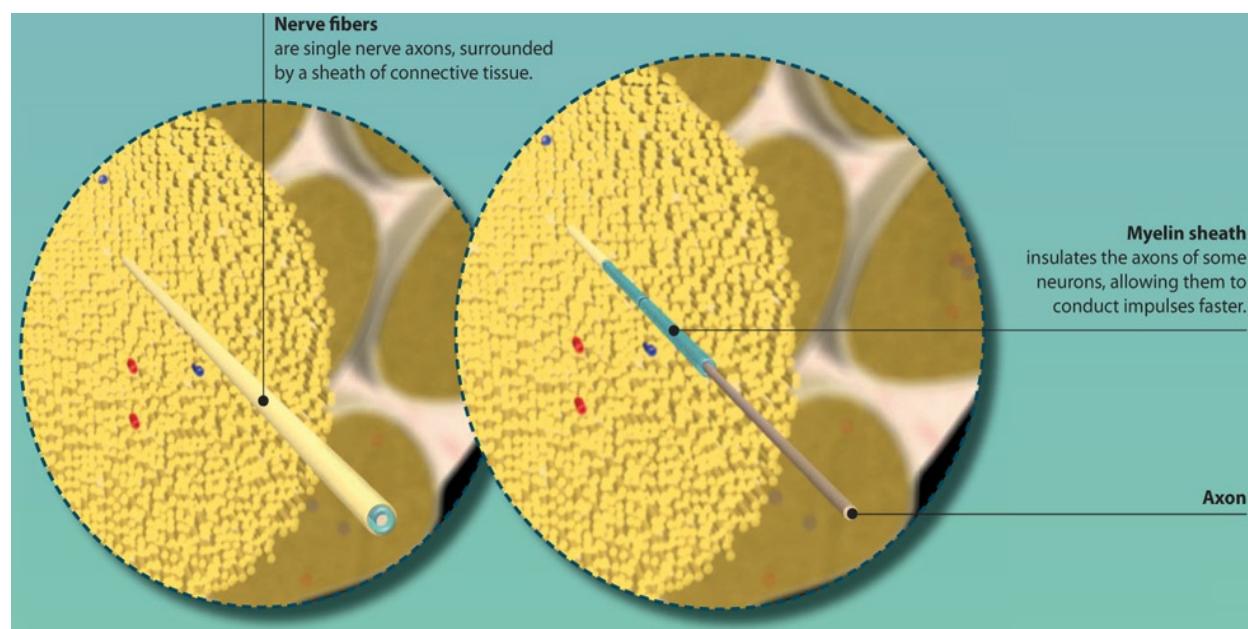
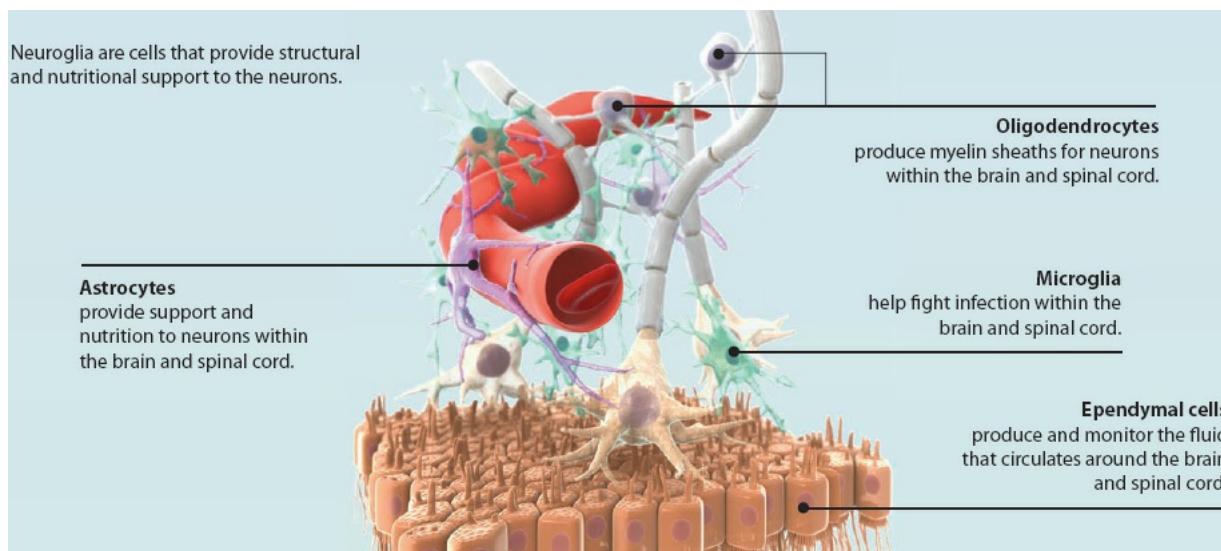


Neurons

Neurons are classified according to the number of fibers entering and leaving their cell body.



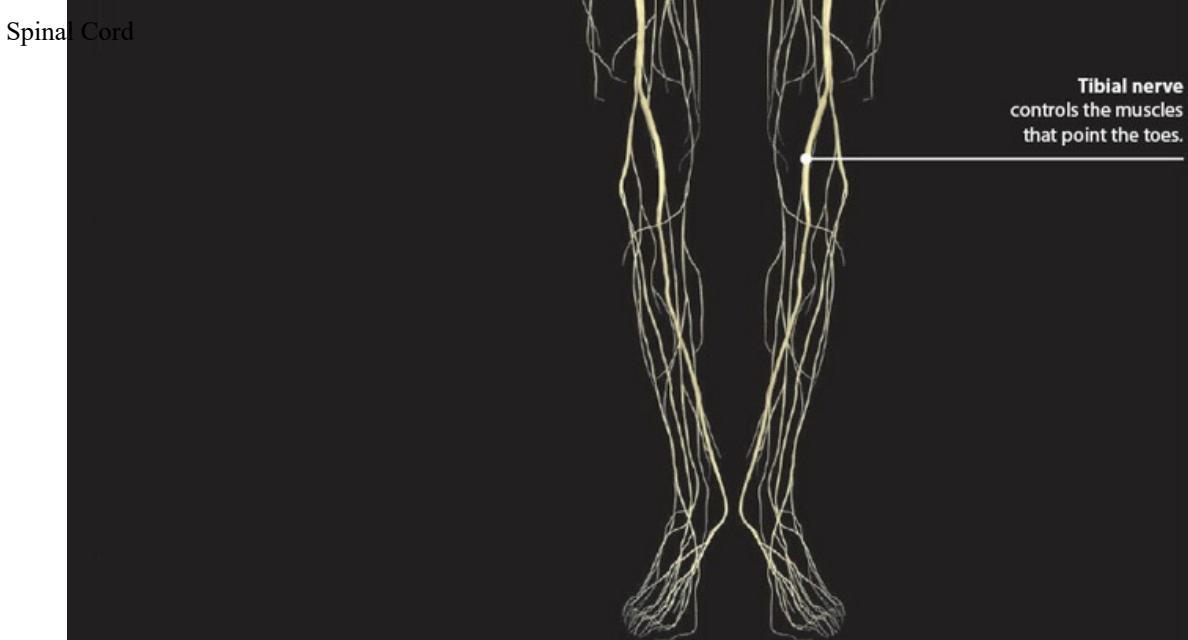
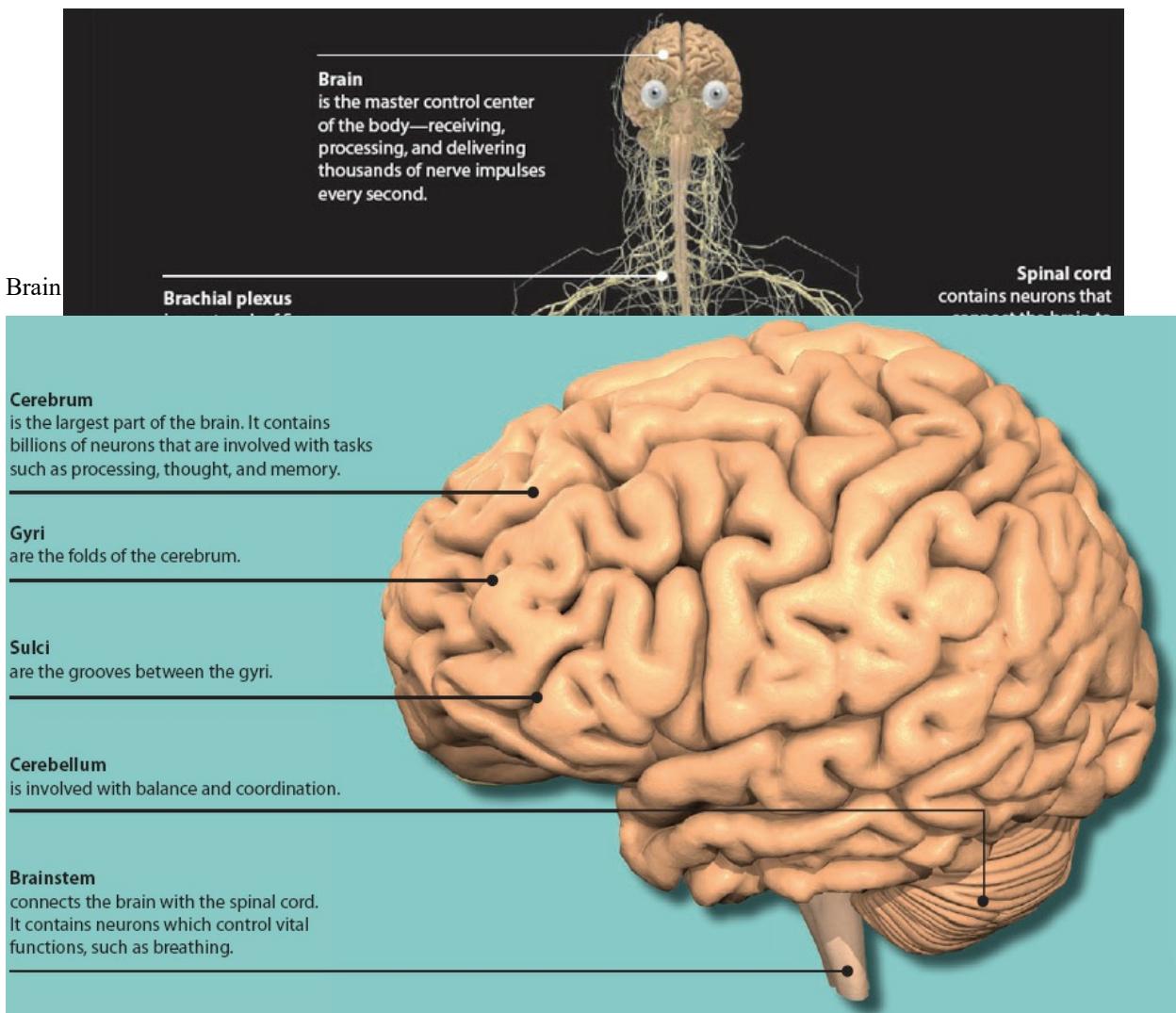
Neuroglia

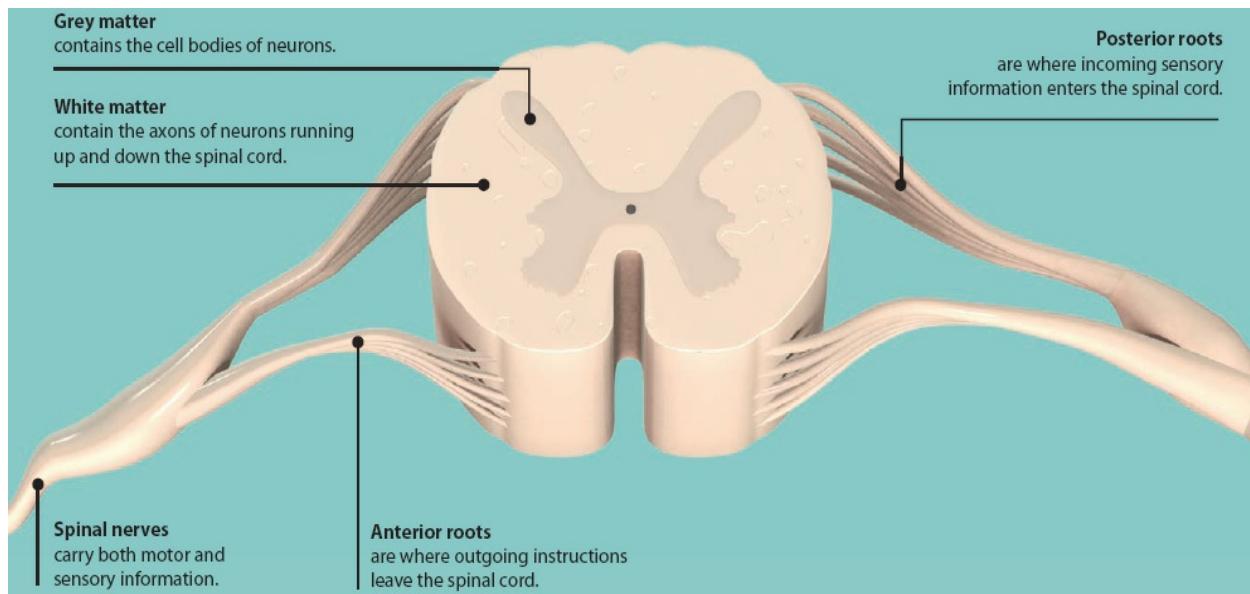


GROSS ANATOMY OF THE NERVOUS SYSTEM

The nervous system is divided into two parts. The central nervous system (CNS) consists of the brain and spinal cord. The peripheral nervous system (PNS) is all the nervous tissue that is outside the CNS.

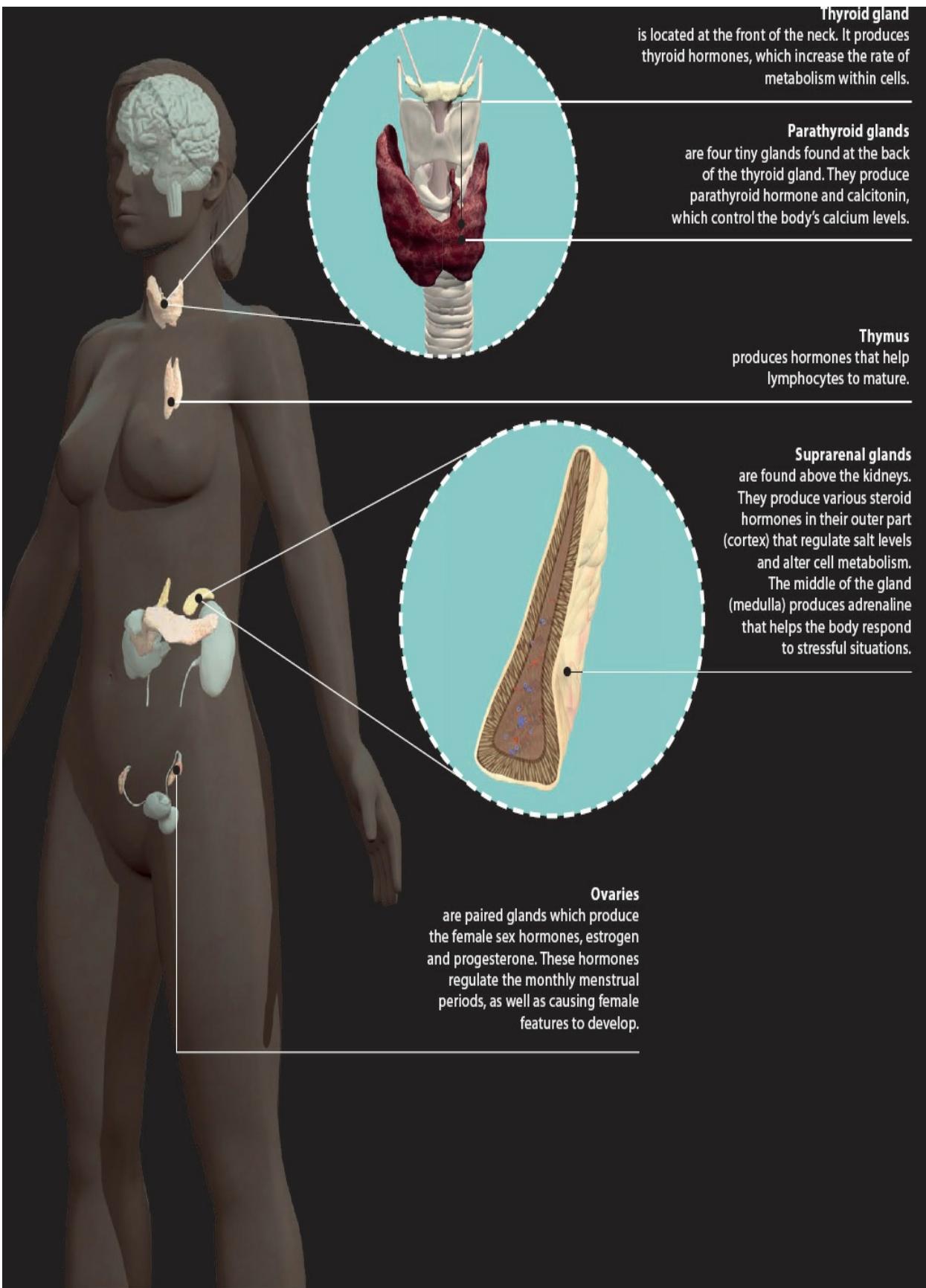
There is constant two-way communication between the CNS and the tissues. Some nerve fibers carry information from the body into the CNS for processing, whereas other fibers relay outgoing instructions to specific tissues.

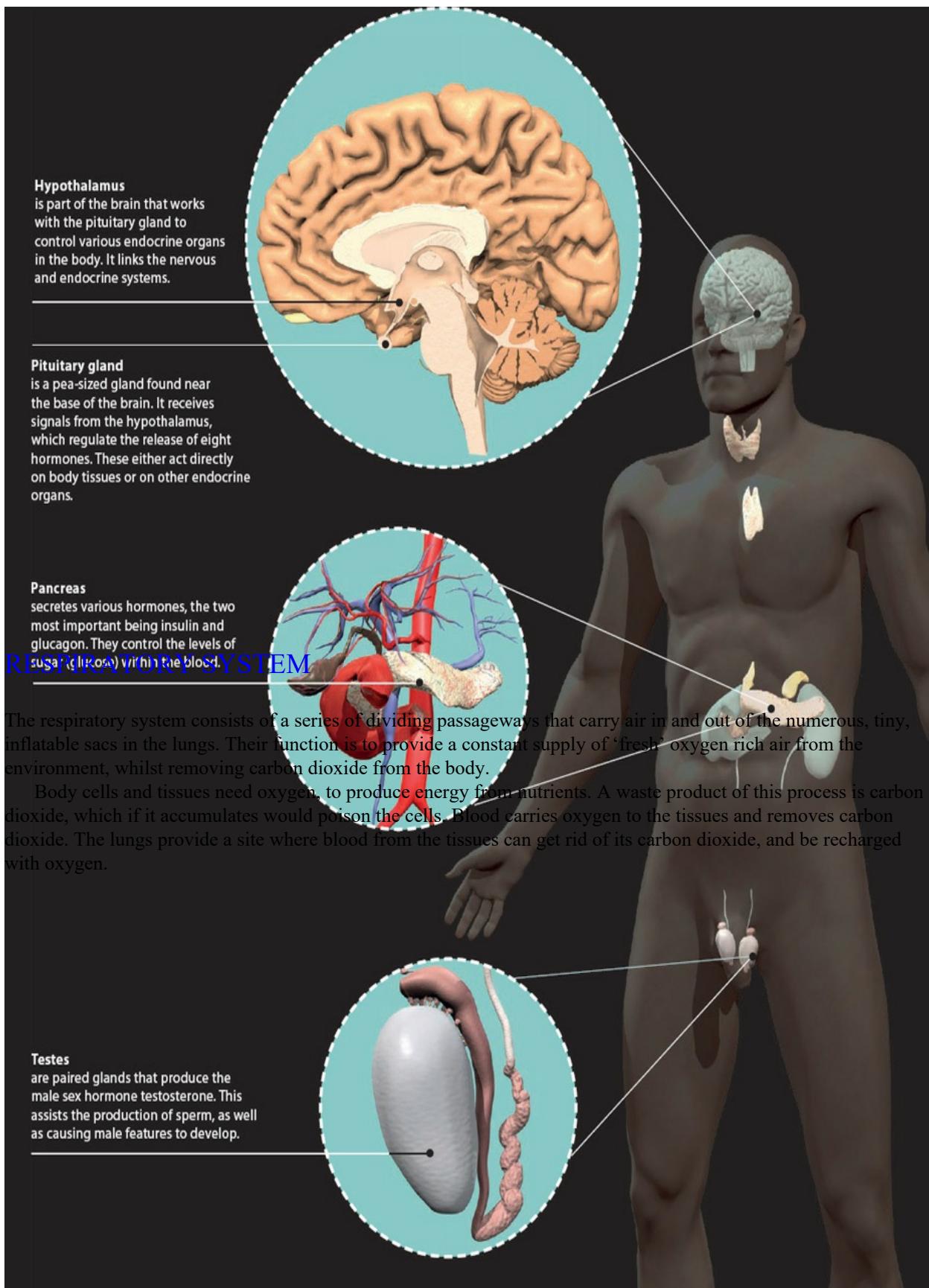


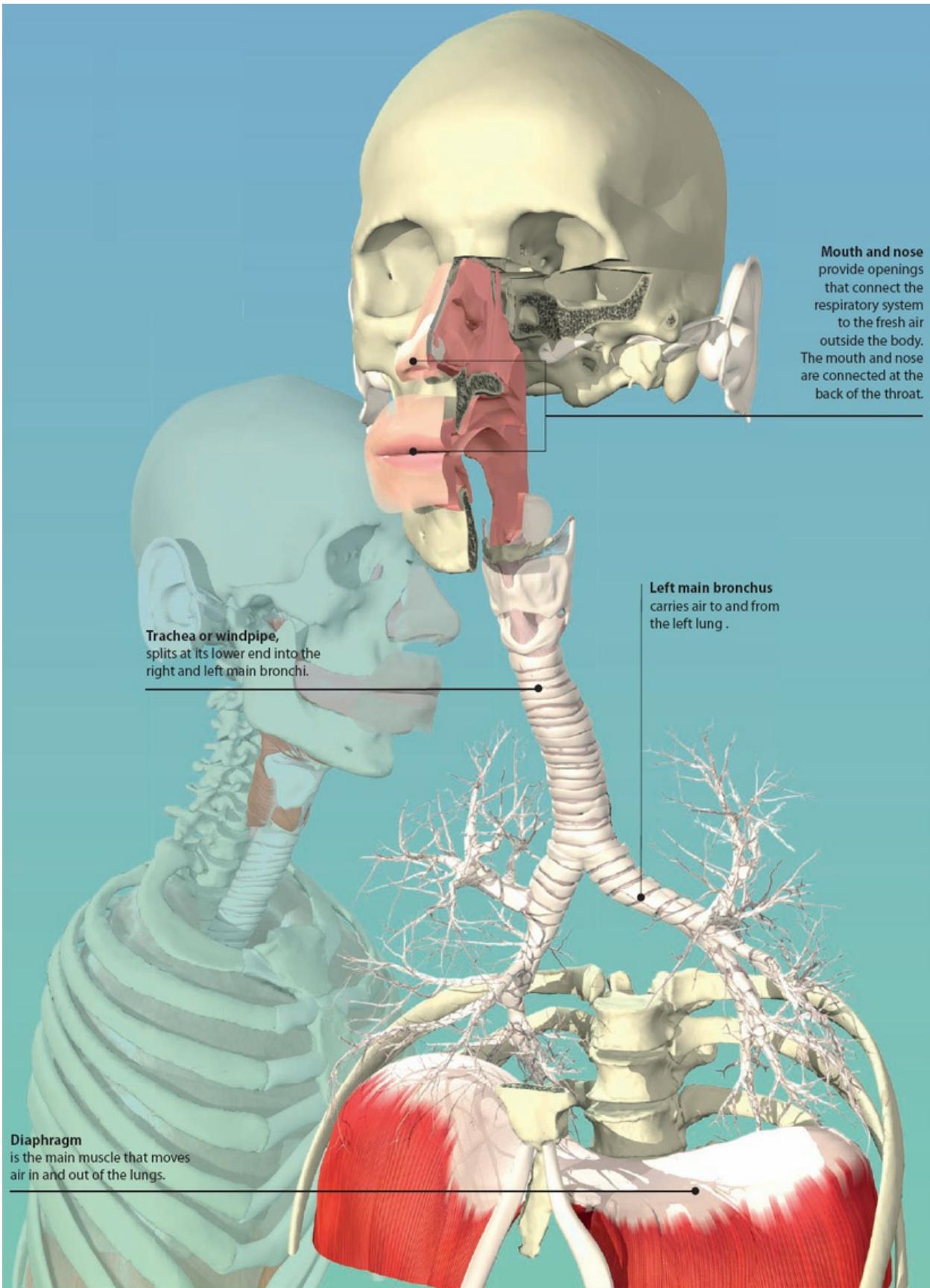


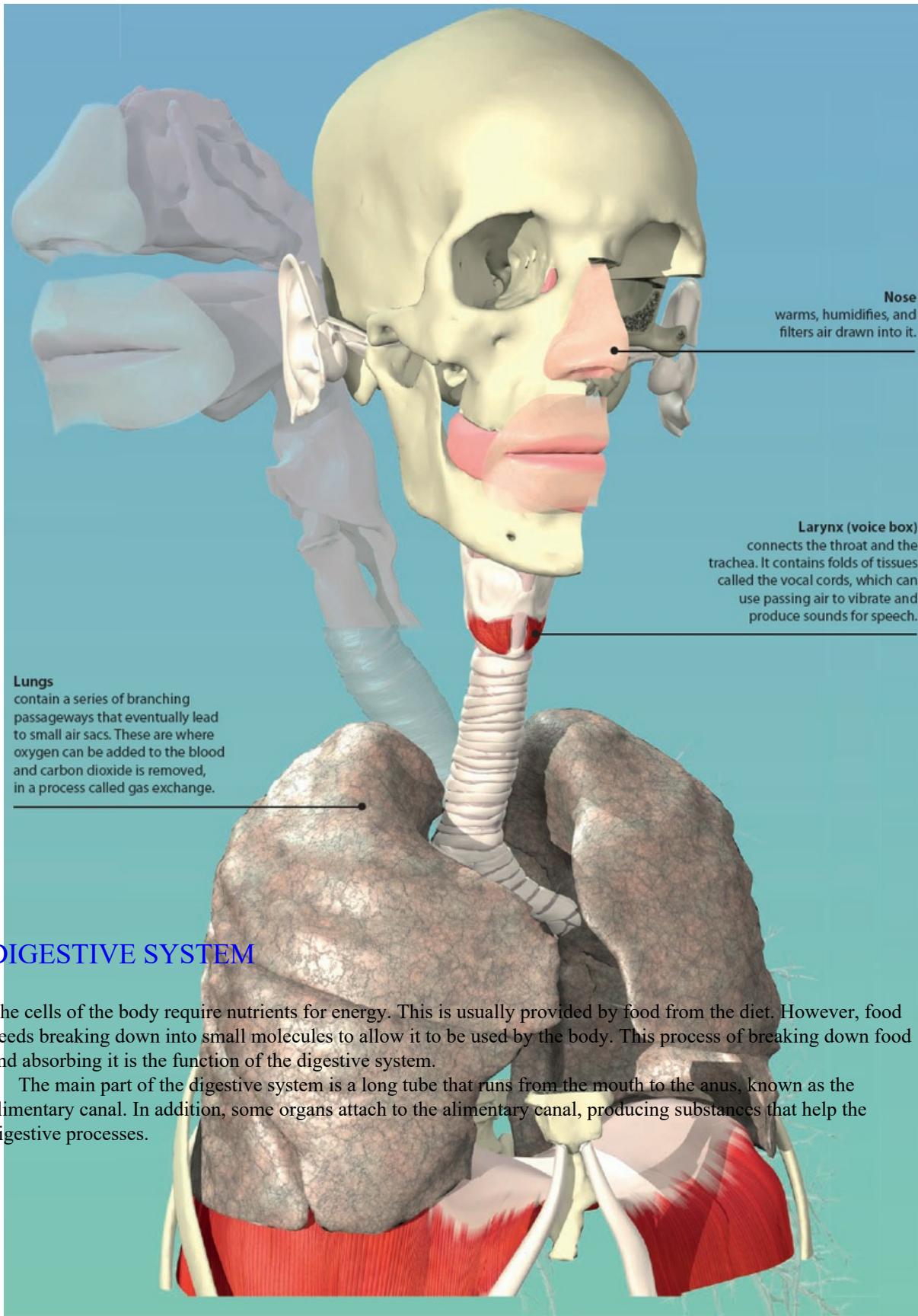
ENDOCRINE SYSTEM

The endocrine system consists of a number of glandular organs spread throughout the body. They control what happens inside the body by releasing chemical messengers, called hormones, into the bloodstream. These hormones act on specific tissues in the body, causing various changes to occur.





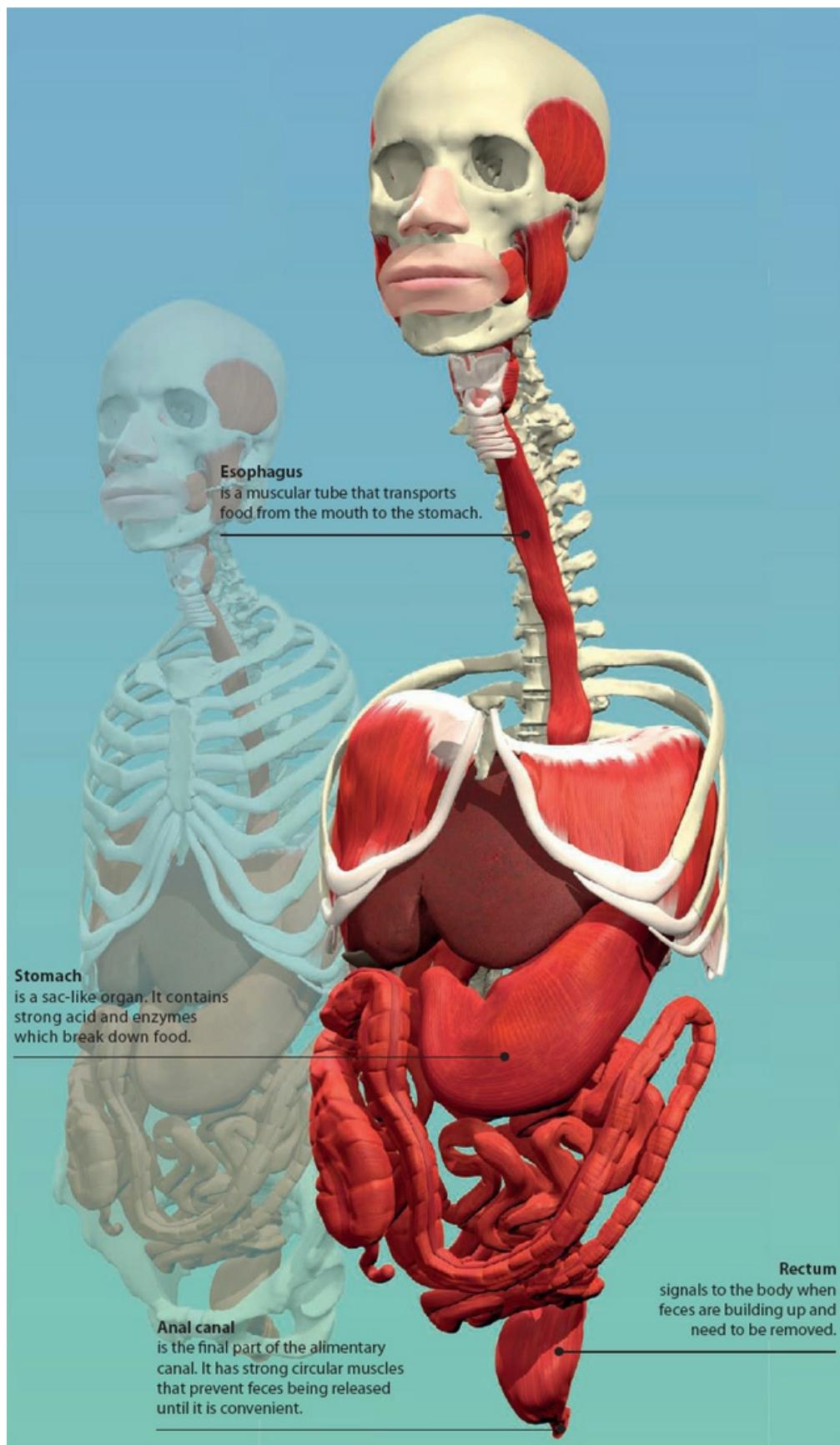


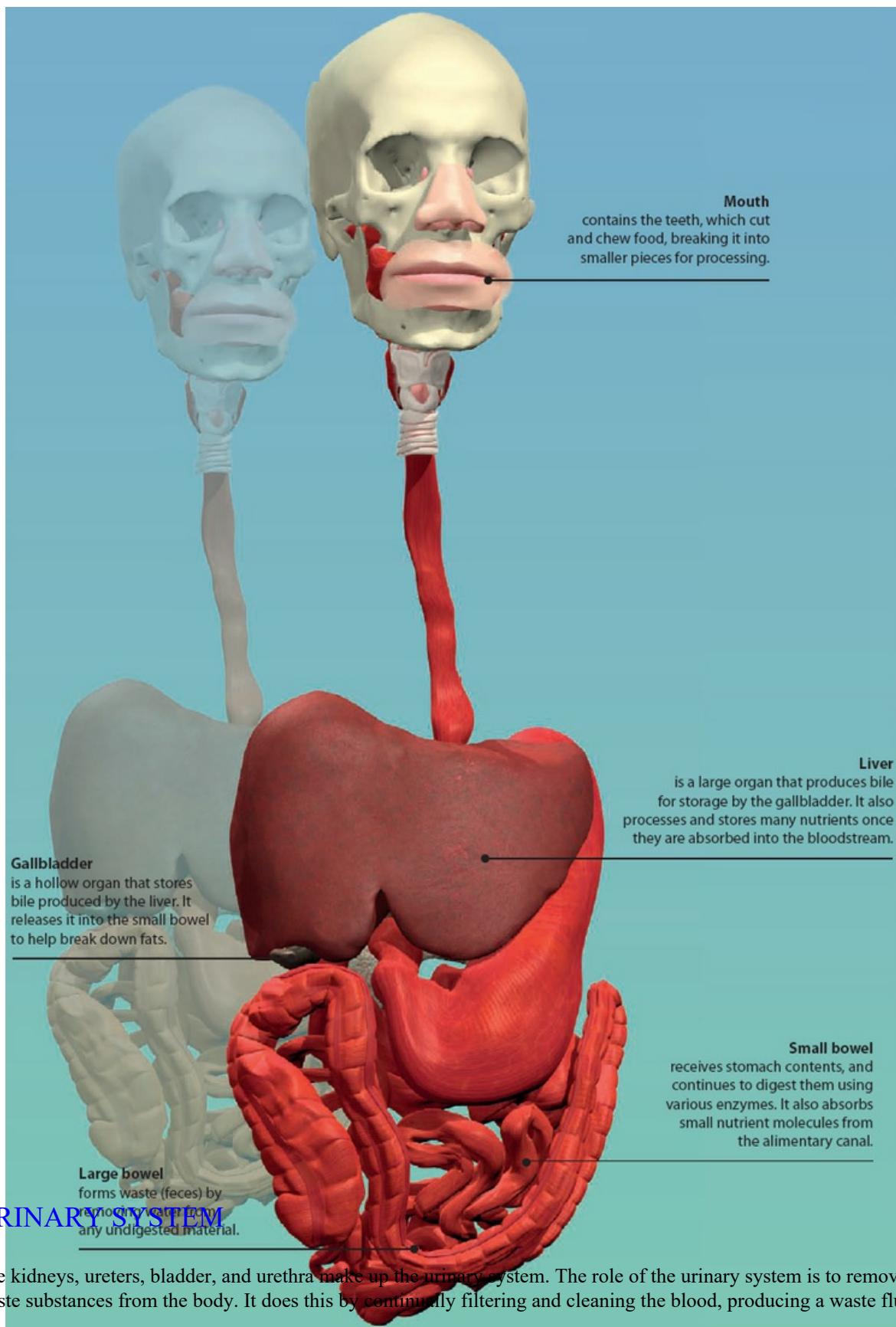


DIGESTIVE SYSTEM

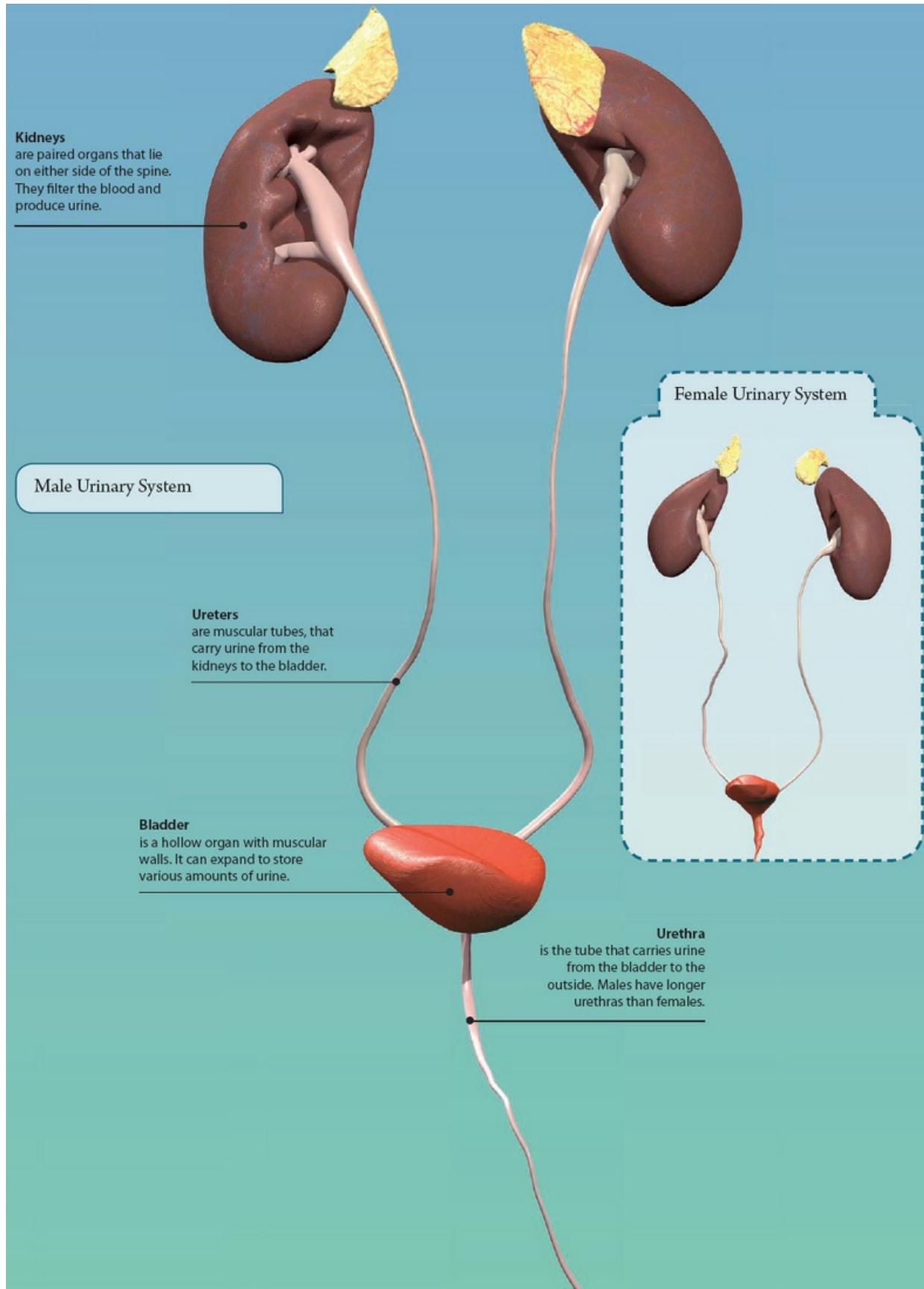
The cells of the body require nutrients for energy. This is usually provided by food from the diet. However, food needs breaking down into small molecules to allow it to be used by the body. This process of breaking down food and absorbing it is the function of the digestive system.

The main part of the digestive system is a long tube that runs from the mouth to the anus, known as the alimentary canal. In addition, some organs attach to the alimentary canal, producing substances that help the digestive processes.





called urine. This can be stored, until an appropriate time and place is found to get rid of it from the body, in a process called urination. The urinary system also helps control the levels of salts and fluid in the body.



Kidney

INTEGUMENTARY SYSTEM

Cortex

is the outer part of the kidney

The integumentary system consists of the skin, along with accessory structures such as hairs, glands, and nails. It provides the body with a waterproof, germ-resistant barrier. It also helps control body temperature, and allows us to touch and feel objects around us.

Did you know? **Calyces** are the "horn-shaped"

The total weight of the skin of an average adult human is 9-11lbs.

The average growth rate of fingernails is 1 millimeter per week. The toenails grow slower than the fingernails.

Medulla
is the inner part that
determines how
concentrated the urine is. It
drains urine into the calyces.

Renal pelvis
is the wide area, which
funnels urine from the
calyces into the ureter.

Ureter

Skin

Hair

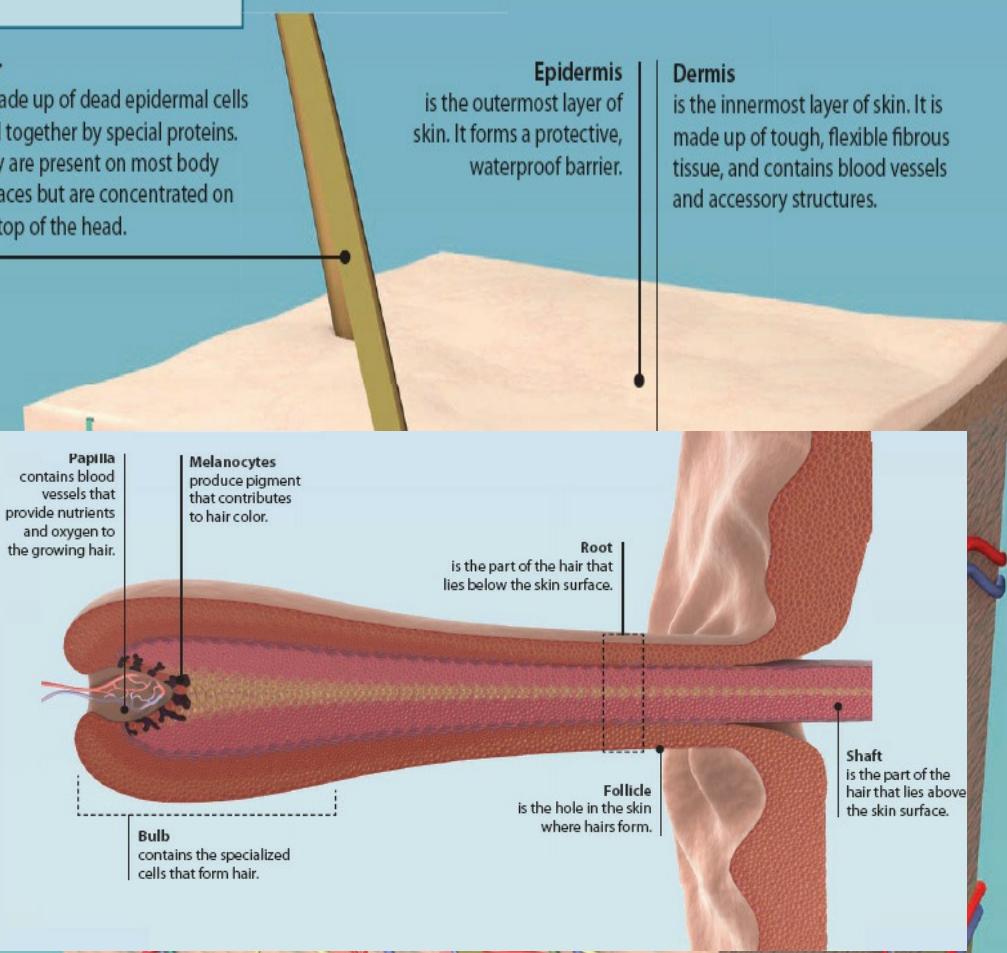
is made up of dead epidermal cells held together by special proteins. They are present on most body surfaces but are concentrated on the top of the head.

Epidermis
is the outermost layer of skin. It forms a protective, waterproof barrier.

Dermis
is the innermost layer of skin. It is made up of tough, flexible fibrous tissue, and contains blood vessels and accessory structures.

Hair

Sebaceous gland
produce an oily substance called sebum, which helps moisturize the skin and hair.

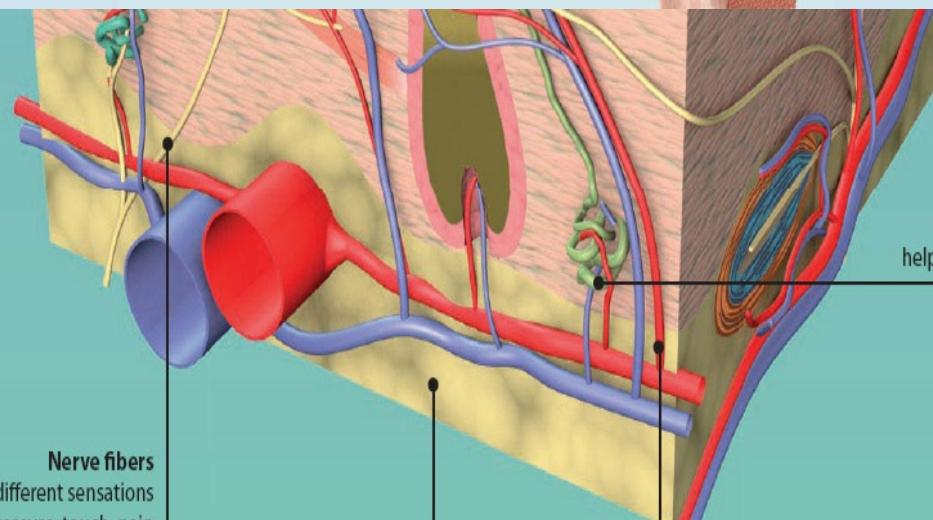


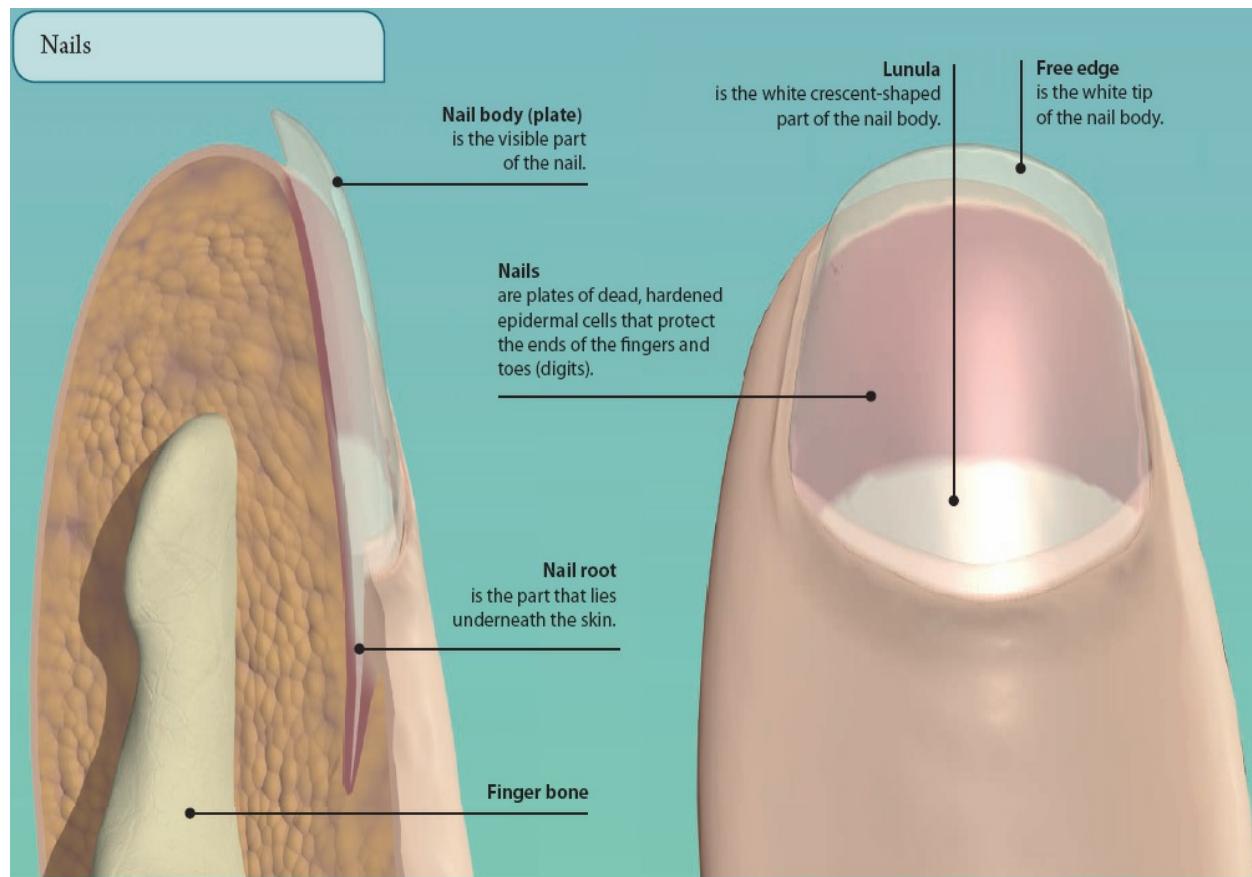
Nerve fibers
detect different sensations like pressure, touch, pain and vibration.

Hypodermis
is a layer of fatty tissue underneath the dermis that helps attach the skin to the body.

Sweat glands
help cool the body.

Blood vessels
help to control body temperature as well as supplying the skin tissues.



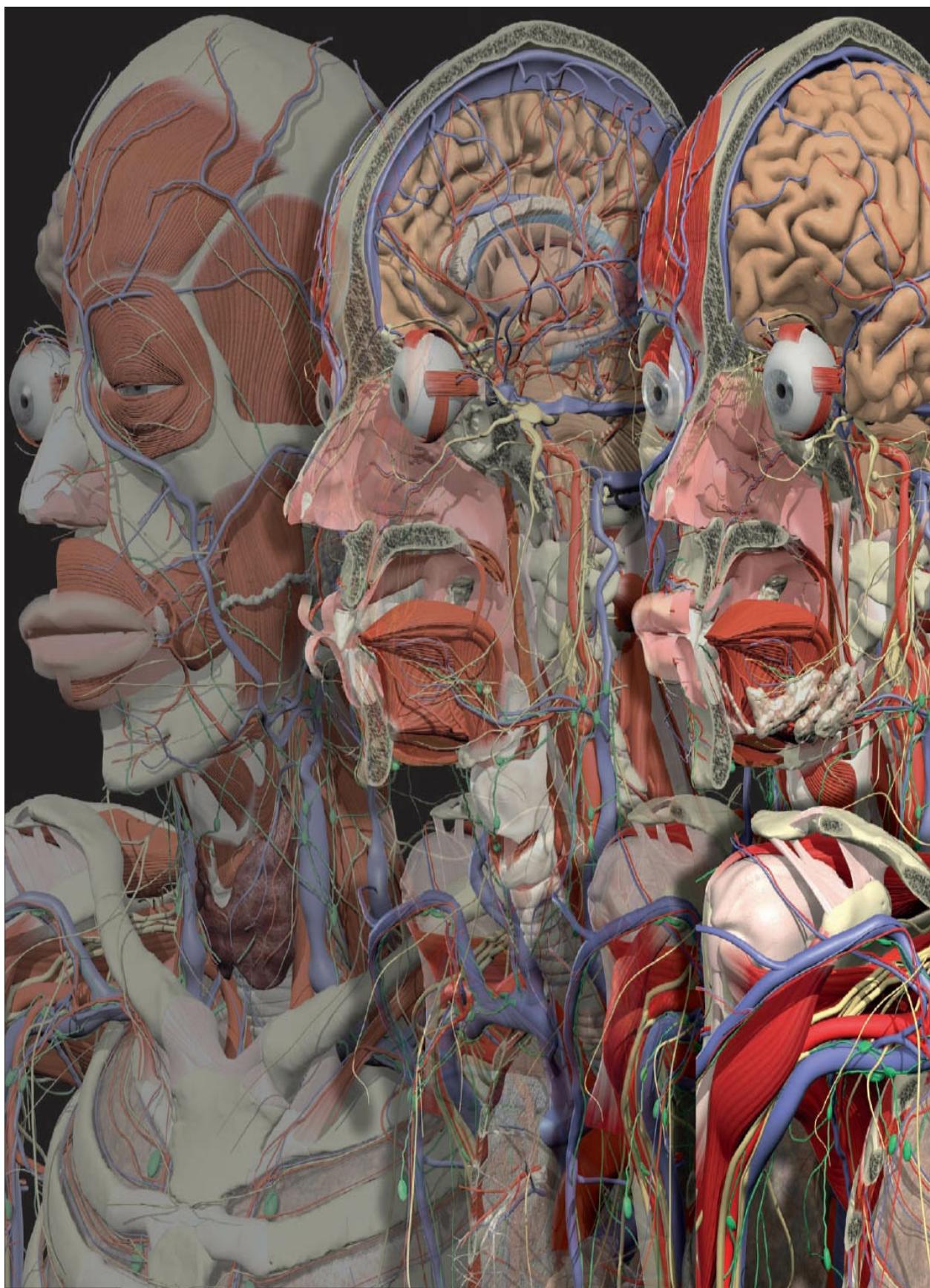


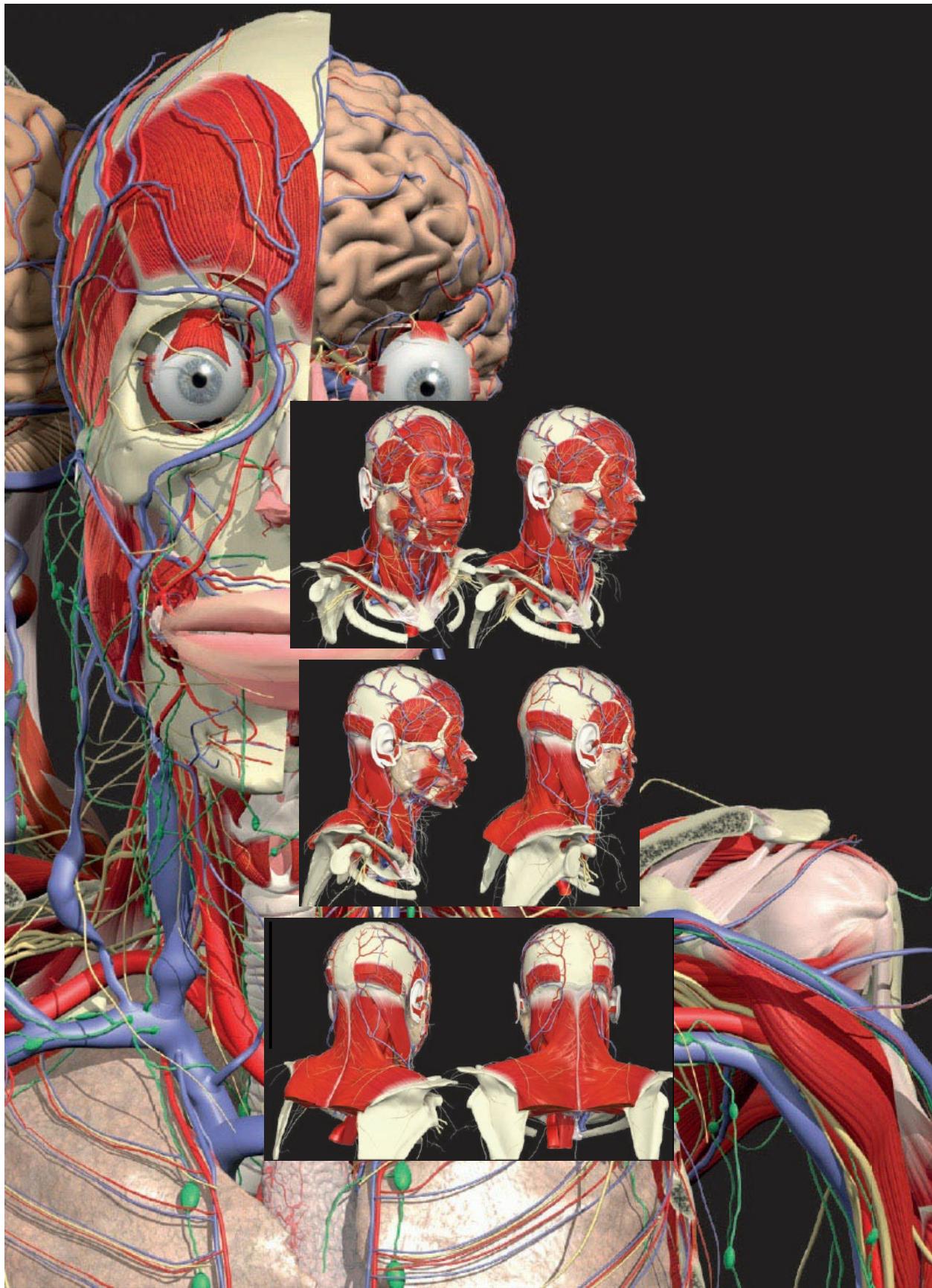
CHAPTER 2: HEAD AND NECK

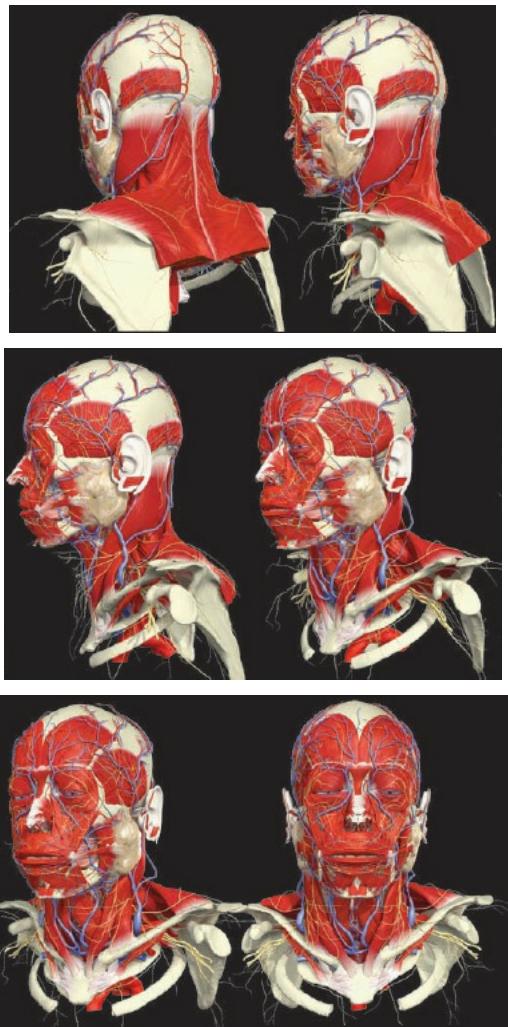
The head contains some of our most important and complex organs, including the brain, eyes, ears, nose, and tongue.

The bony skull provides protection to these delicate structures, as well as giving shape to our face. The mouth and nose provide openings to the outside world, allowing us to take in food, water, and air, while the numerous muscles help us to speak, chew, and show whether we are happy or sad.

The neck supports and moves the head. It is also the communication channel between the structures of the head and the rest of the body. Running through the neck are the spinal cord, the windpipe, the esophagus, and many large blood vessels.

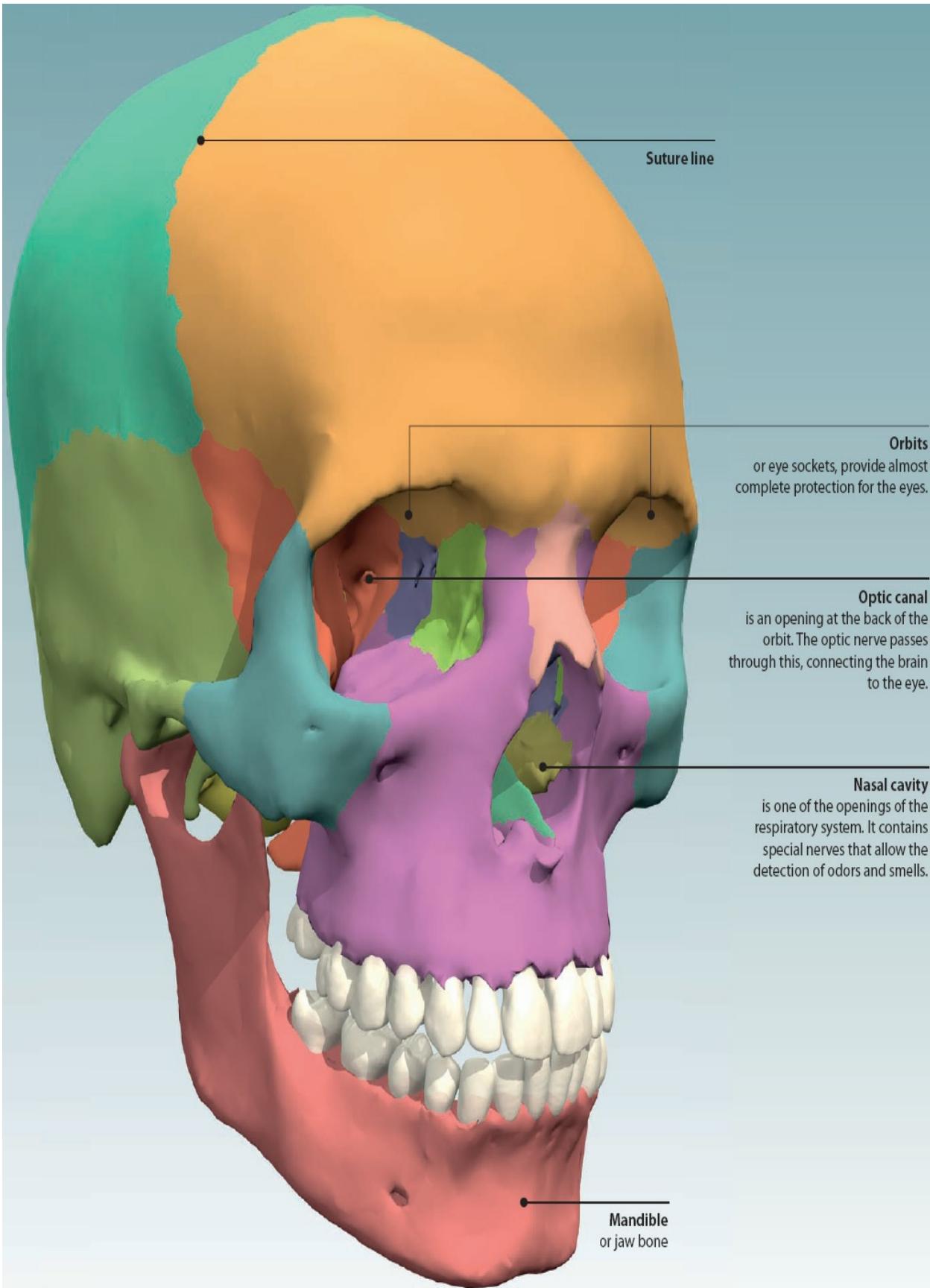


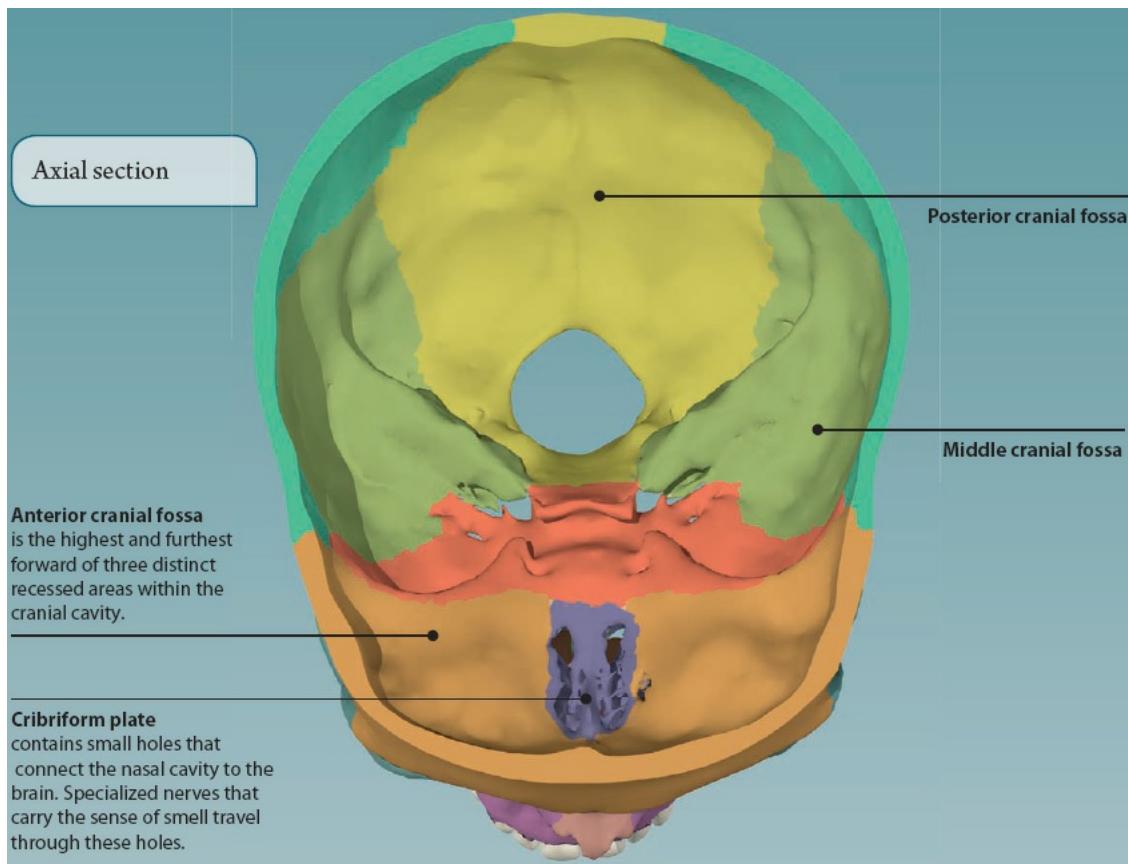


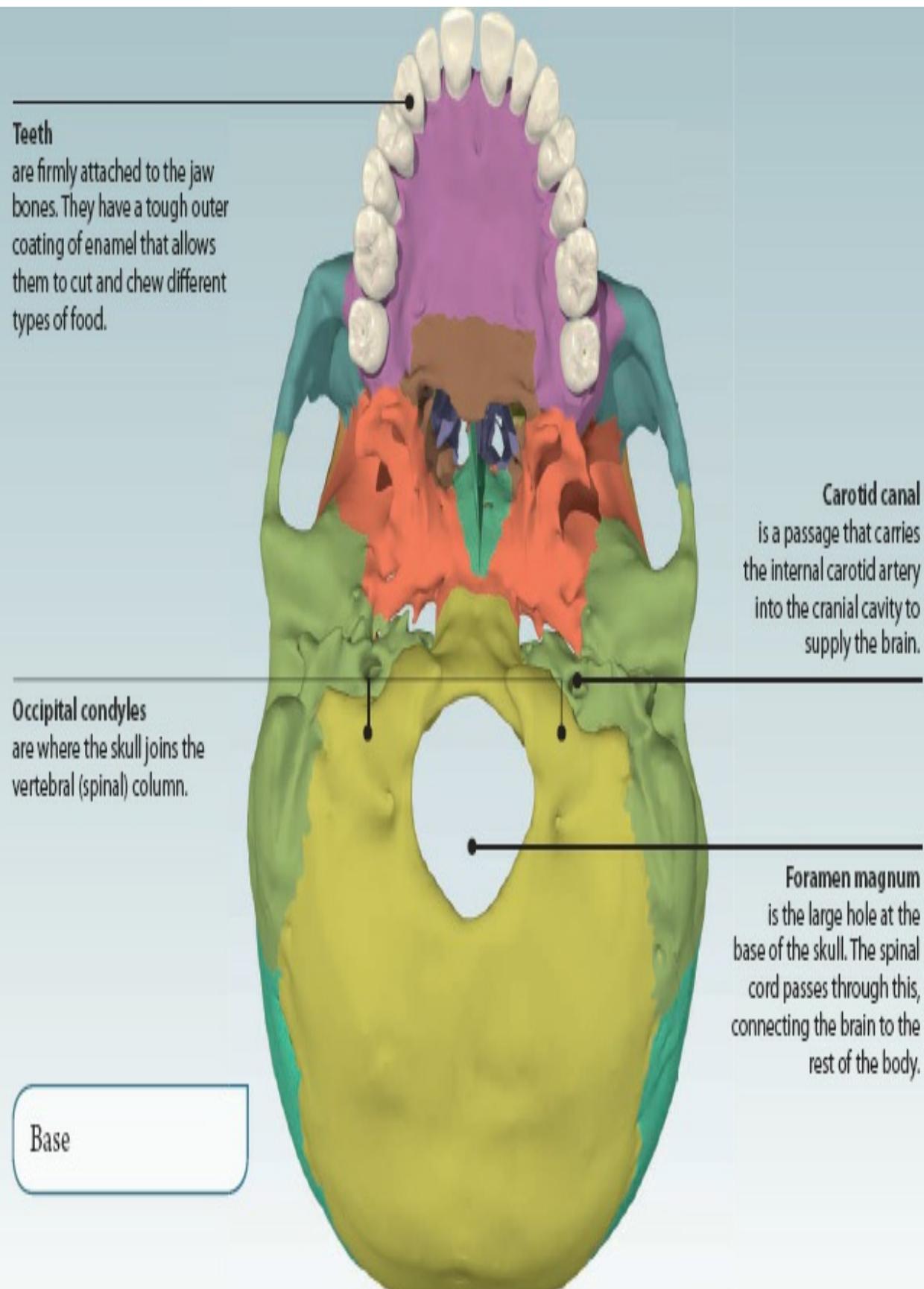


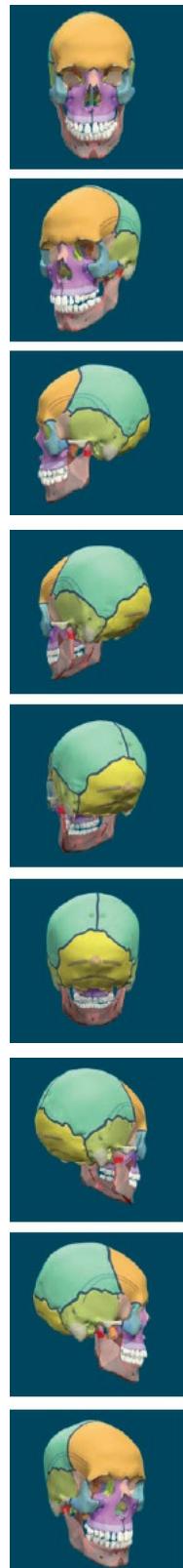
THE CRANIUM

The cranium, or skull, is made up of a number of individual bones that are fixed together at fused joints called sutures. It provides protection for delicate structures, such as the brain and the eyes, and also provides a solid base for muscles of the head and neck to attach to. The area inside the skull is called the cranial cavity, and houses the brain. Within the bones there are holes, called foramen, which allow the passage of nerves and blood vessels to and from the cranial cavity.



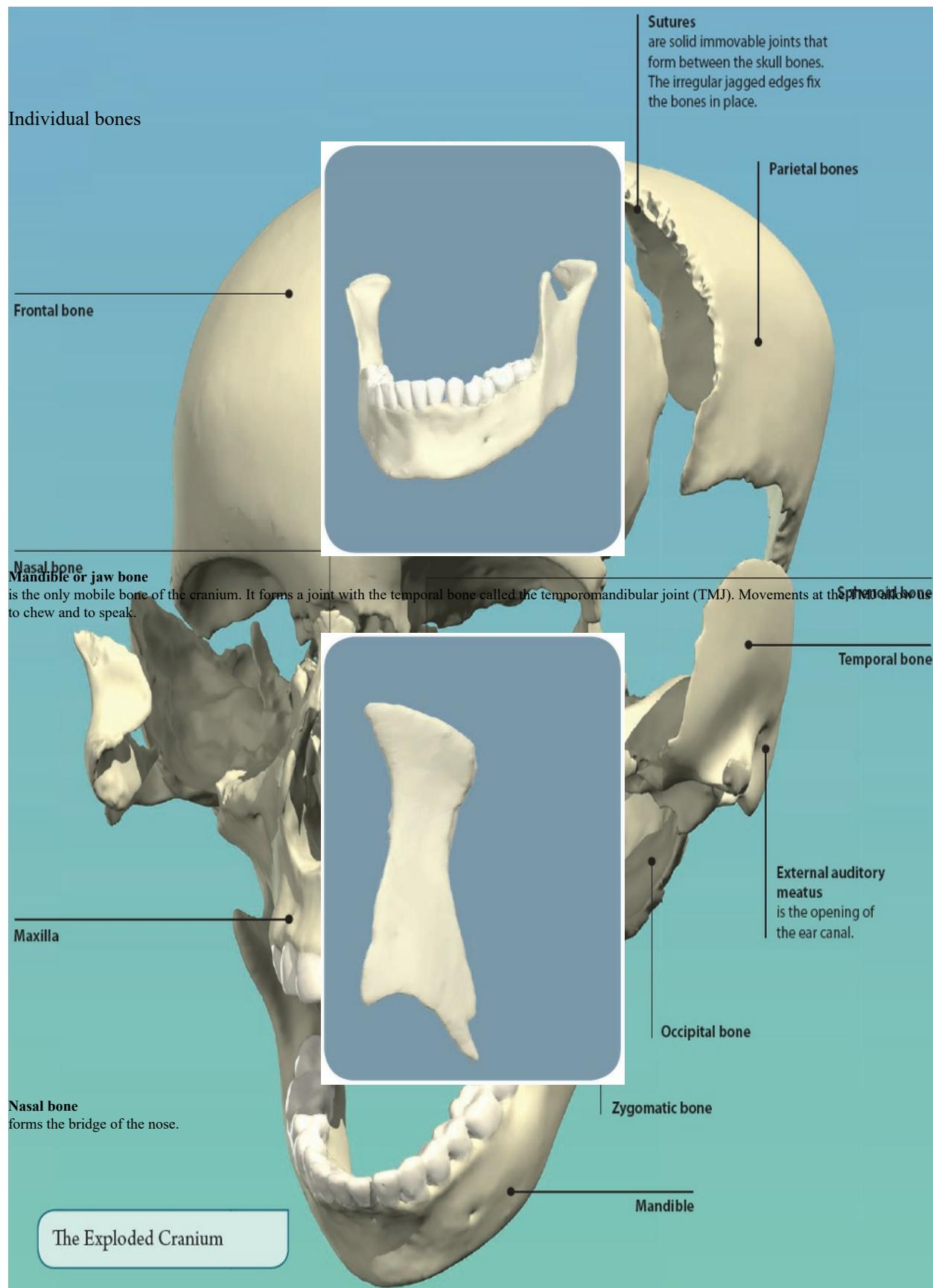






EXPLODED CRANIUM

The cranium, or skull bone, is made up of twenty-two separate bones. Of these, eight cranial bones form the cranial cavity which houses the brain. The remaining fourteen bones form the face, and are known as facial bones. Most of the bones are fixed in place and are attached to each other by irregular joint lines called sutures.

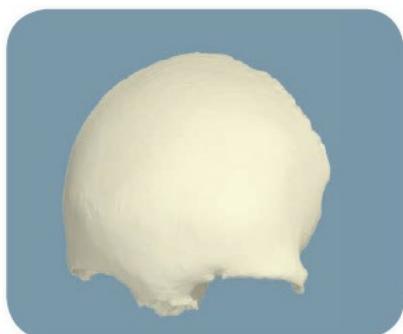


**Temporal bone**

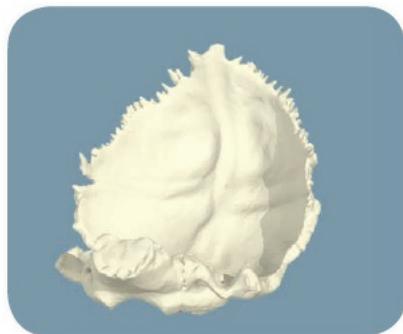
forms the side of the head and contains the delicate organs of hearing.

**Parietal bone**

protects the top and sides of the head.

**Frontal bone**

gives shape to the forehead and forms the upper part of the orbit.

**Occipital bone**

forms the back and much of the base of the skull.



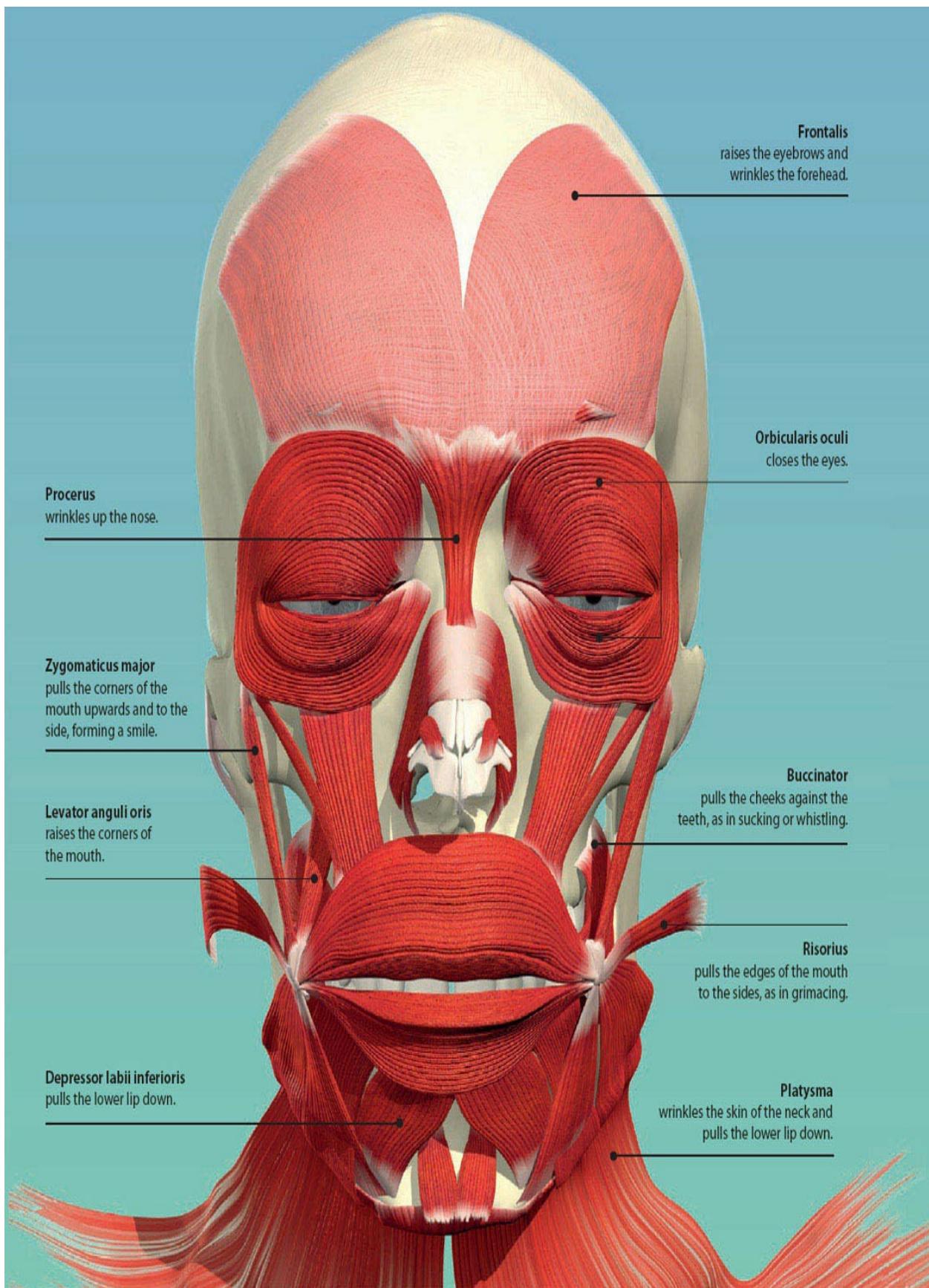
Zygomatic bone
give shape to the cheeks.

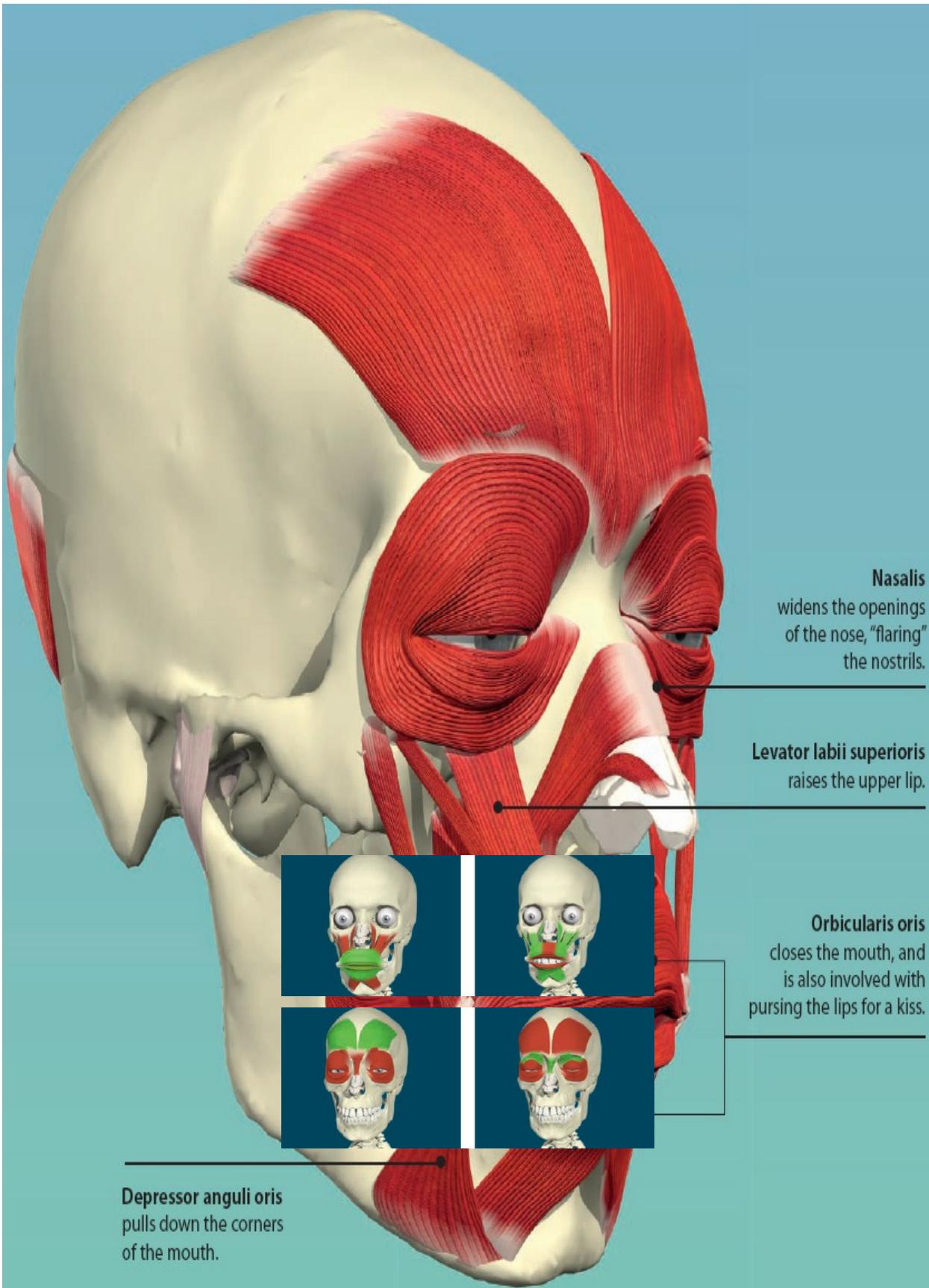


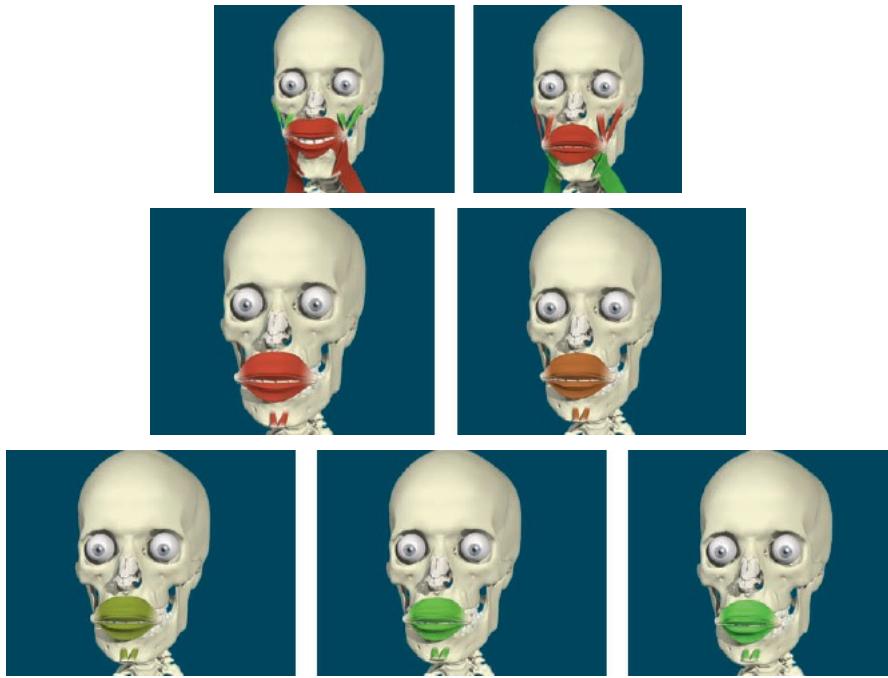
Maxilla
forms the upper lip and much of the face. It also forms part of the hard palate inside the mouth.

MUSCLES OF FACIAL EXPRESSION

The muscles of facial expression allow us to show how we are feeling through the movements and appearance of the face. They are an unusual group of muscles, as instead of just connecting to bones, one of their ends is attached to the skin. This means that when they contract, they move the overlying skin, generating different facial expressions. We use these muscles to show a wide range of emotions—from happiness and surprise, to anger and sadness. Their names often give clues to their action, or what they are attached to. They are all supplied by the facial nerve.



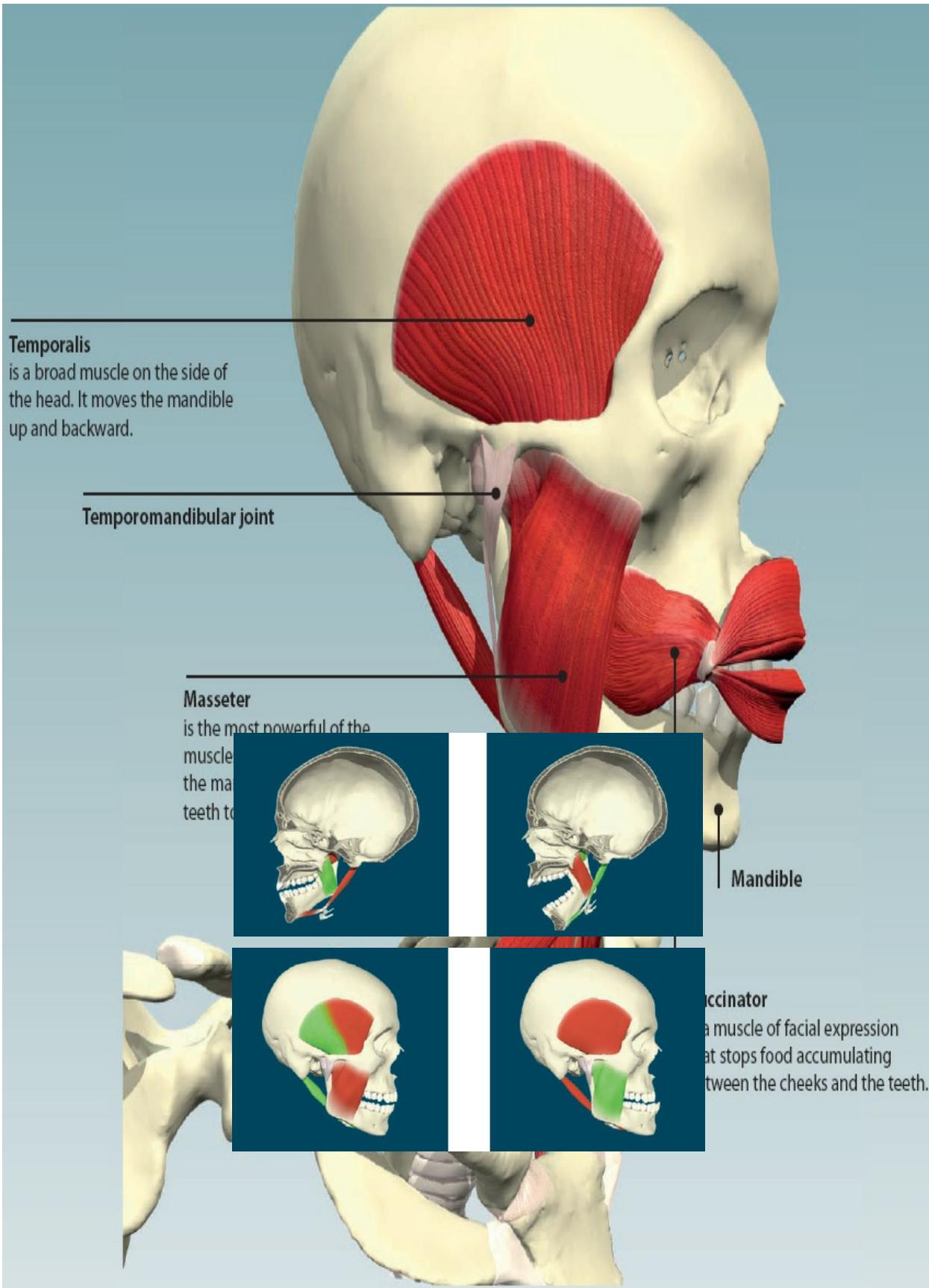


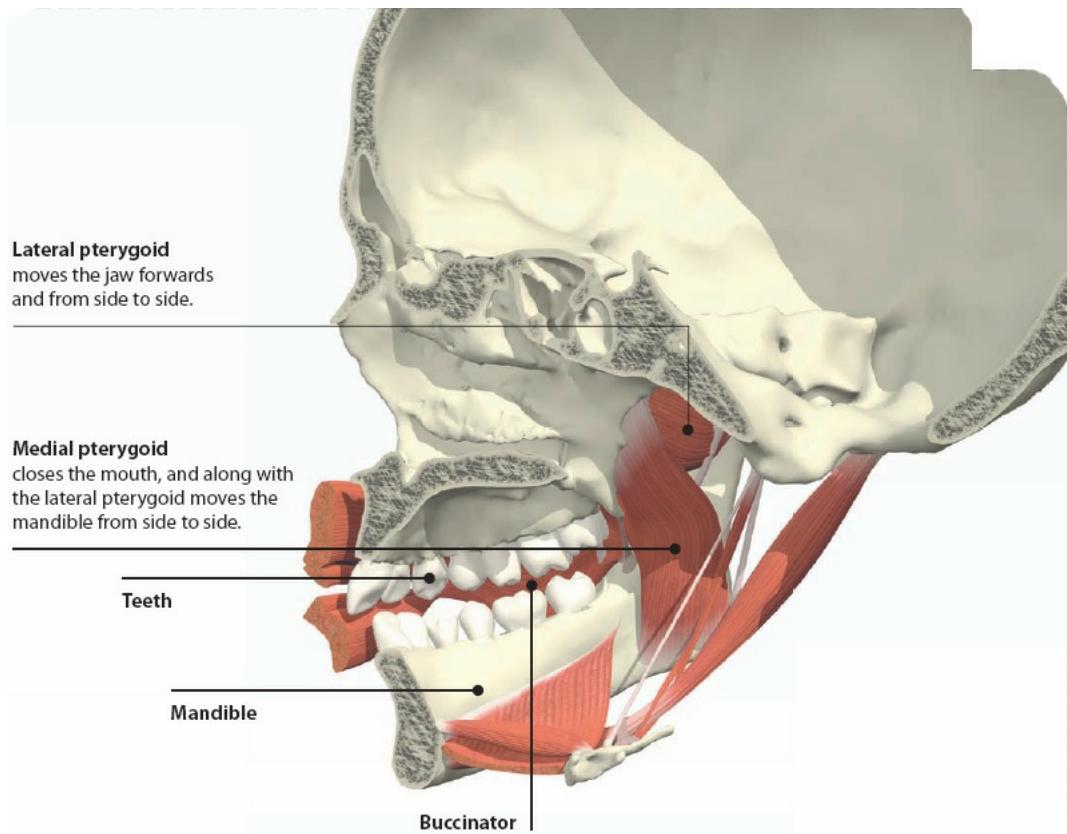
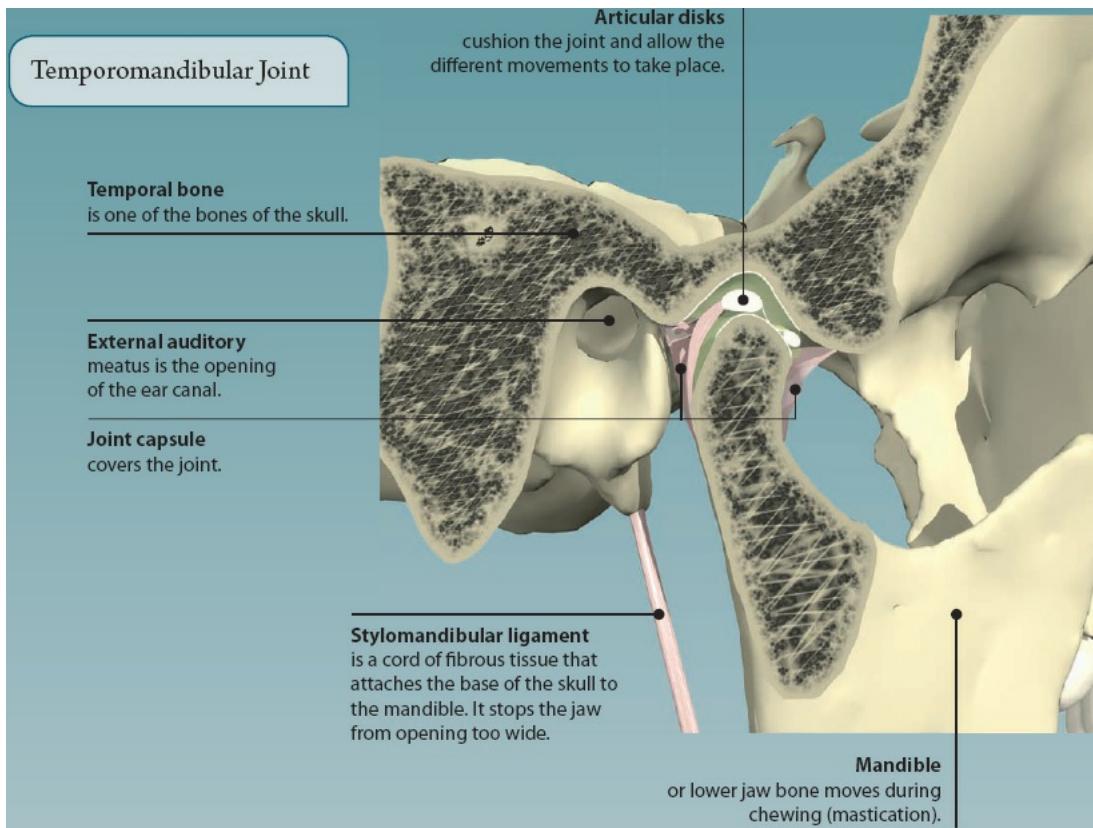


JAW AND MUSCLES OF MASTICATION

The upper and lower jaw contains teeth, which are used to cut and chew food. Four strong muscles work together to produce movements necessary for chewing and are known as the muscles of mastication (chewing). They move the lower jaw (mandible) up and down, backward and forward, and from side to side.

Movements of the mandible take place at the temporomandibular joint (TMJ). This joint is formed where the lower jaw bone meets the skull, just in front of the ear.







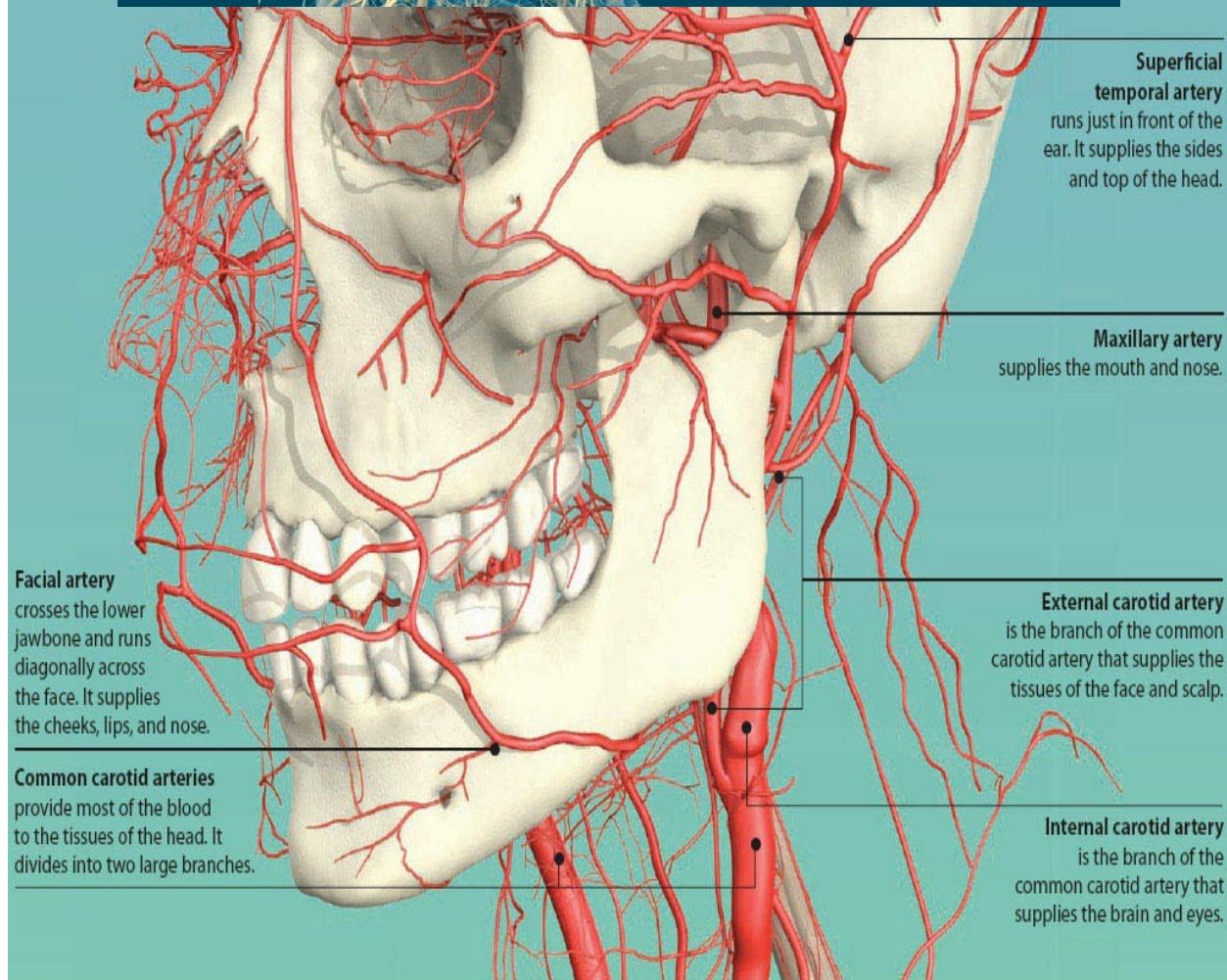
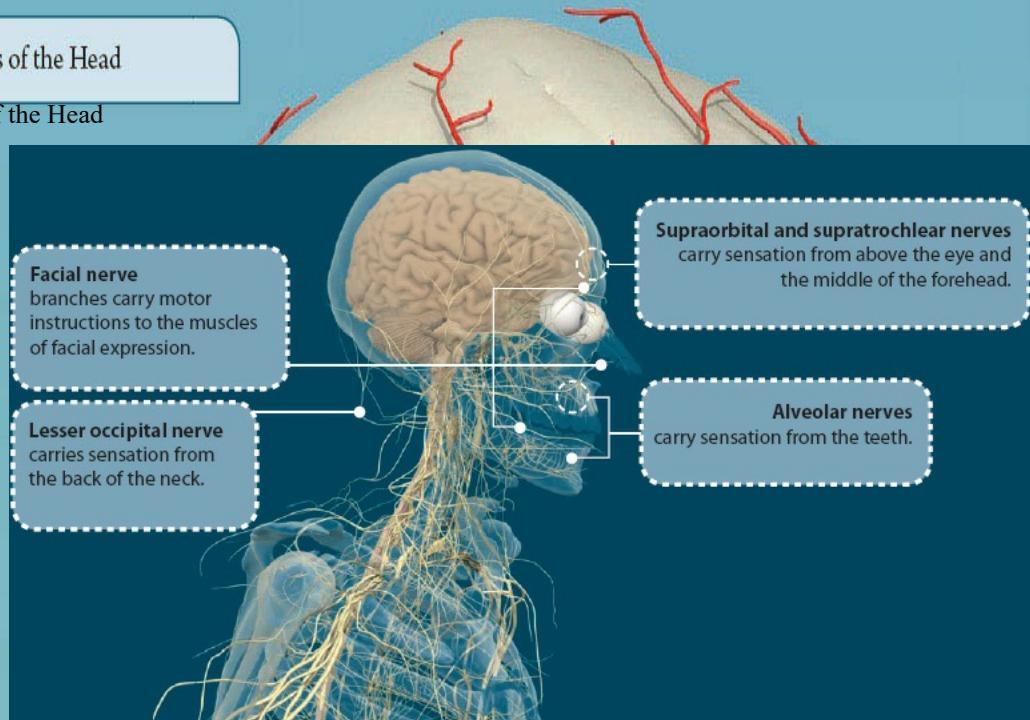
NEUROVASCULAR STRUCTURES OF THE HEAD

Neurovascular structures are the arteries, veins, and nerves that supply, drain, and innervate tissues in a particular

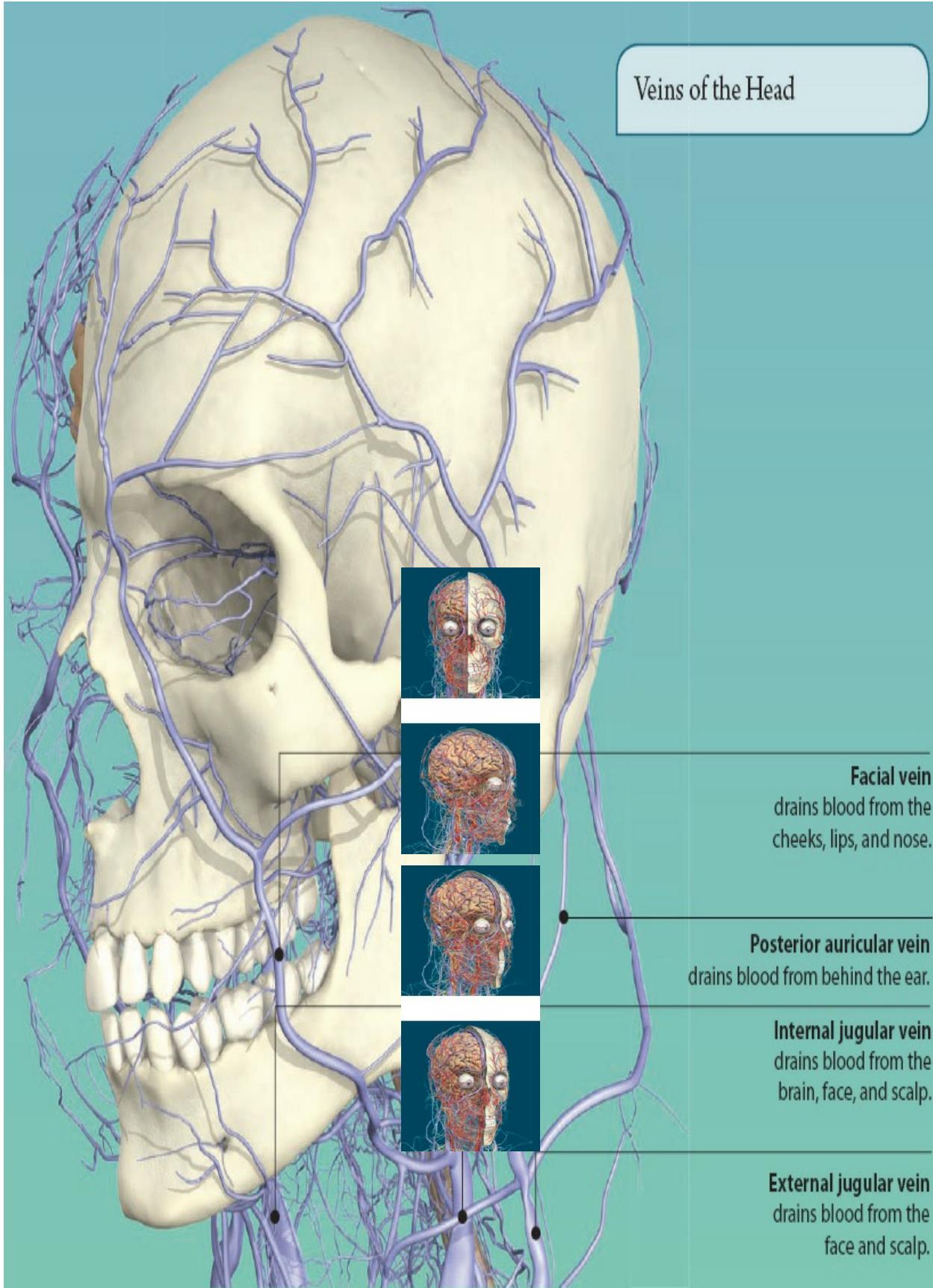
body region. In the head, they form large branching networks that cover the face, scalp, nasal, and oral cavities, along with the brain and eyes.

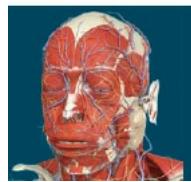
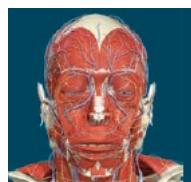
Arteries of the Head

Nerves of the Head



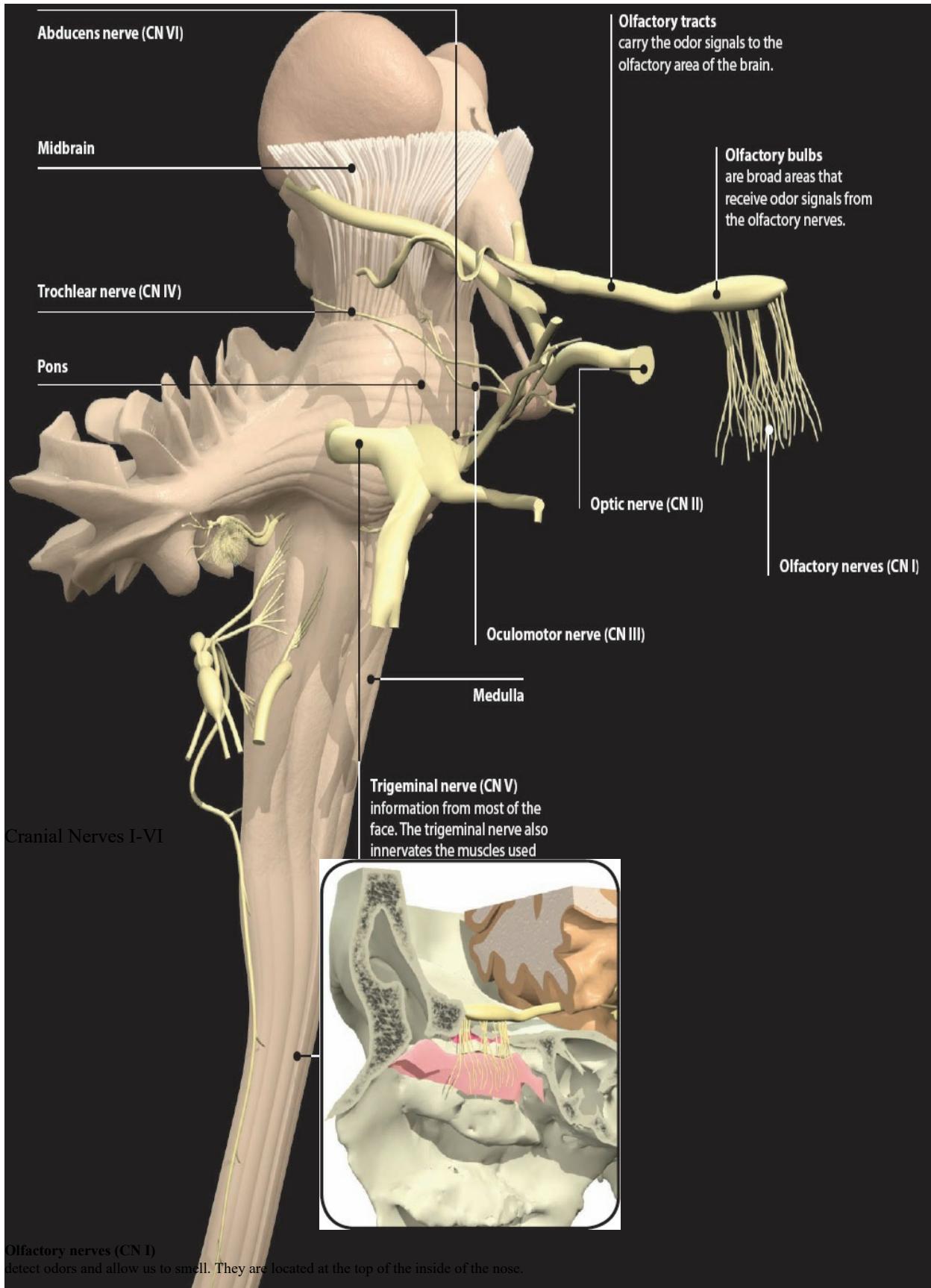
Veins of the Head

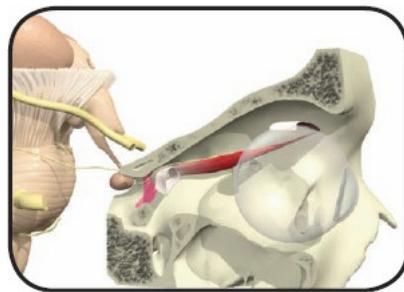




CRANIAL NERVES I-VI

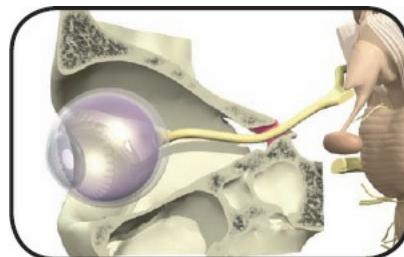
The cranial nerves are so named as they all emerge directly out of the brain, within the cranial cavity. There are twelve pairs of cranial nerves (CN) that are numbered using Roman numerals. Between them, they provide motor and sensory innervation to the head and neck regions. They all pass through various holes in the skull to reach the areas they supply. The first six cranial nerves allow us to smell, to see, to move our eyes, as well as providing sensation to the face, and motor control to the muscles of mastication.





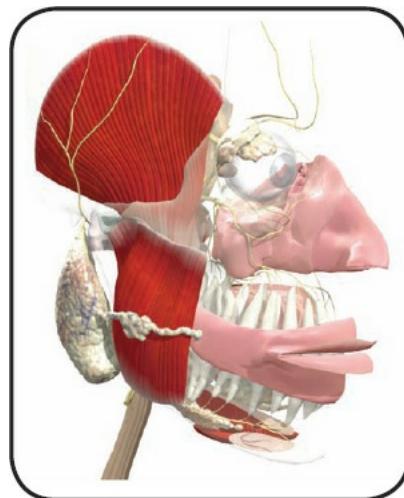
Trochlear nerve (CN IV)

controls a muscle that helps rotate the eye down and out.



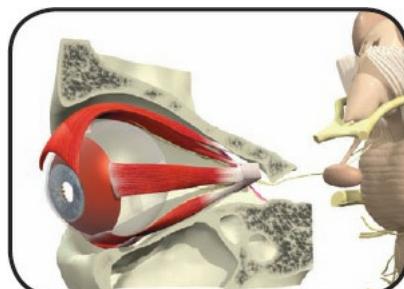
Optic nerve (CN II)

carries visual information from the back of the eyes to the brain to allow us to see.



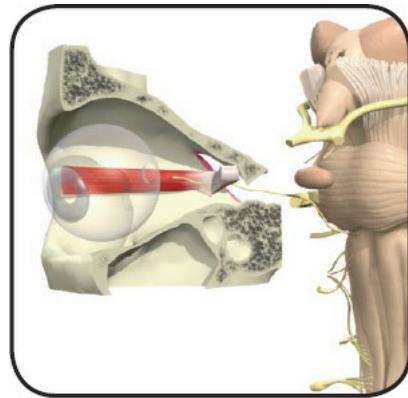
Trigeminal nerve (CN V)

has three main branches; the ophthalmic, maxillary, and mandibular divisions. Between them they carry sensory information from most of the face. The trigeminal nerve also innervates the muscles used for chewing (mastication).



Oculomotor nerve (CN III)

controls most of the muscles that move the eyeball. It also opens the eyelids, and makes the pupils of the eyes smaller.

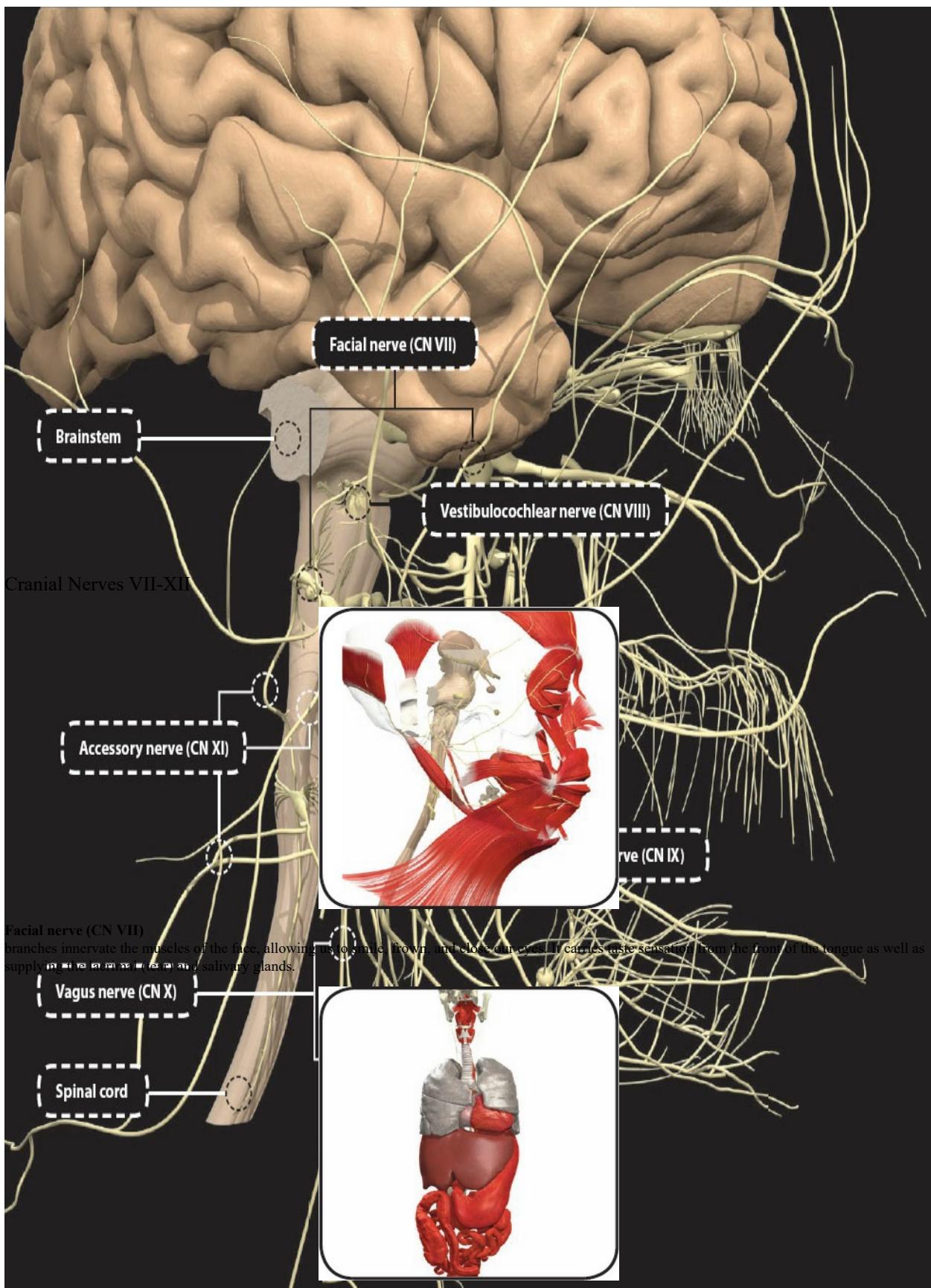


Abducens nerve (CN VI)

controls the muscle that makes the eye look to the side.

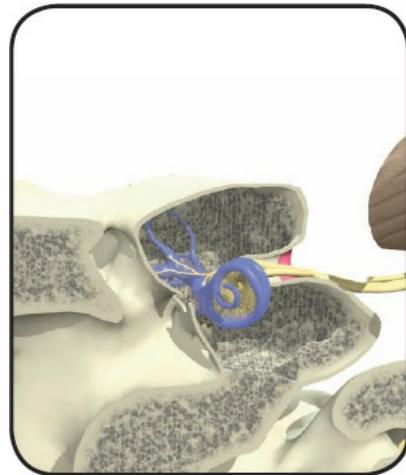
CRANIAL NERVES VII-XII

Cranial nerves (CN) VII to XII have a wide variety of functions. They control the muscles of facial expression, and allow us to hear, keep our balance, shrug our shoulders, taste, swallow, and cry. By traveling outside the head and neck regions, the vagus nerve helps control the heart and gastrointestinal system. These nerves can even make our mouths water, by supplying the salivary glands.



Vagus nerve (CN X)

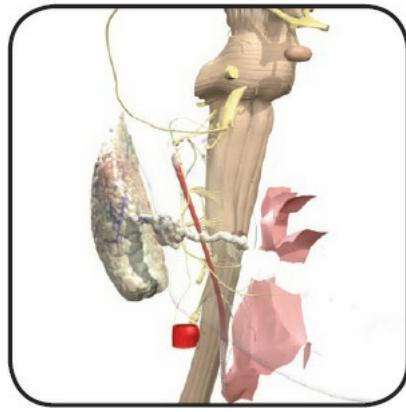
innervates muscles of the throat and larynx (voicebox) that allow us to swallow, speak, and cough. It is known as the “wandering” nerve, as it travels down into the chest and abdomen, where it helps control the cardiovascular and gastrointestinal systems.

**Vestibulocochlear nerve (CN VIII)**

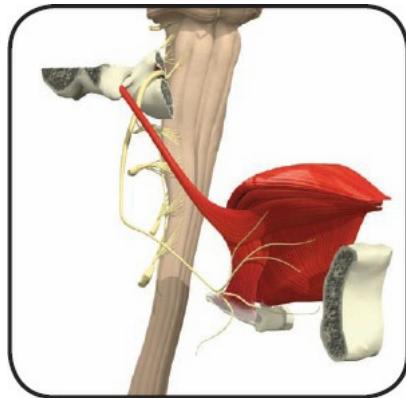
has two branches, allowing us to hear (cochlear part) and to keep our balance (vestibular part).

**Accessory nerve (CN XI)**

has branches from both the brainstem and the spinal cord. It innervates muscles in the neck and upper back that shrug the shoulders and turn the head.

**Glossopharyngeal nerve (CN IX)**

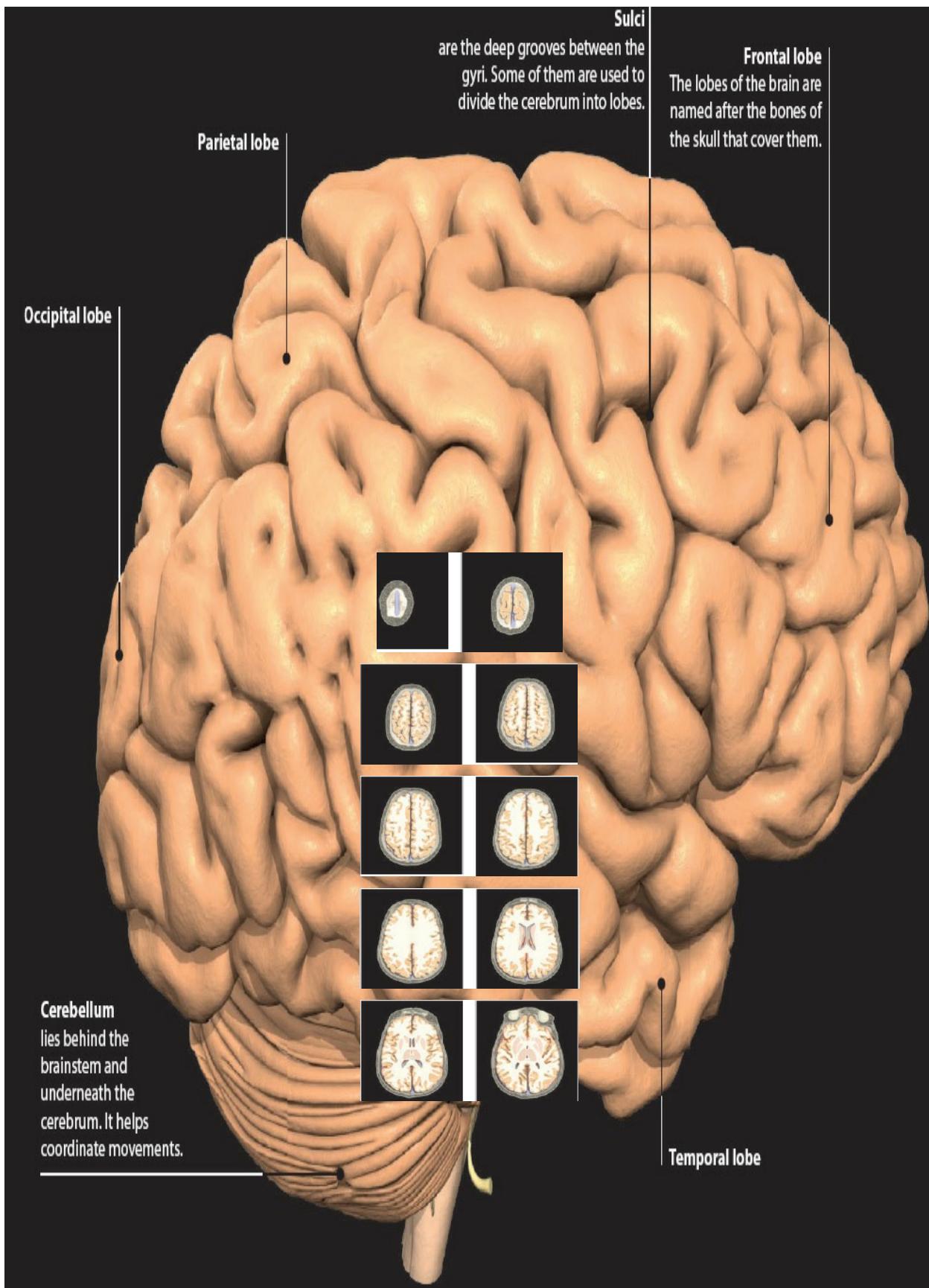
is predominantly a sensory nerve, carrying information from the back of the throat (pharynx) and deep structures of the neck. These signals allow us to swallow properly, as well as controlling the blood pressure.



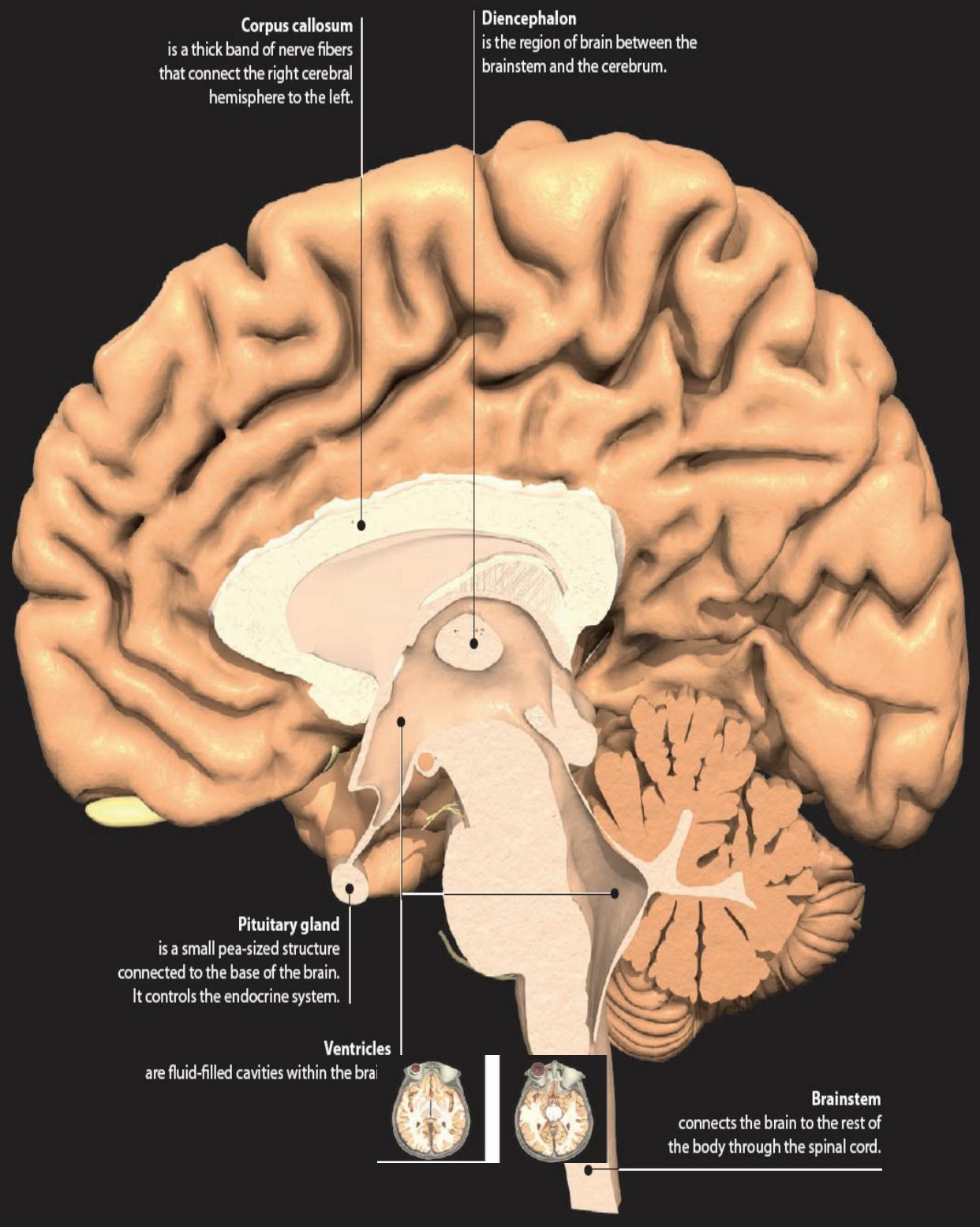
Hypoglossal nerve (CN XII)
controls the muscles that move the tongue.

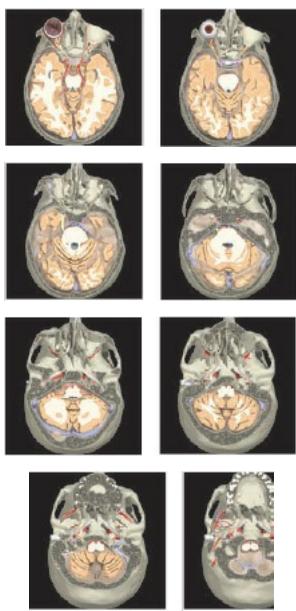
BRAIN

The brain is the master control center of the body, coordinating the activities of the body systems. It allows the body to move, feel, think, remember, and speak, performing thousands of complex calculations every second. It is a relatively small organ considering its importance, weighing just over a kilogram. The brain can be divided into distinct areas, all serving different functions.



Medial Section

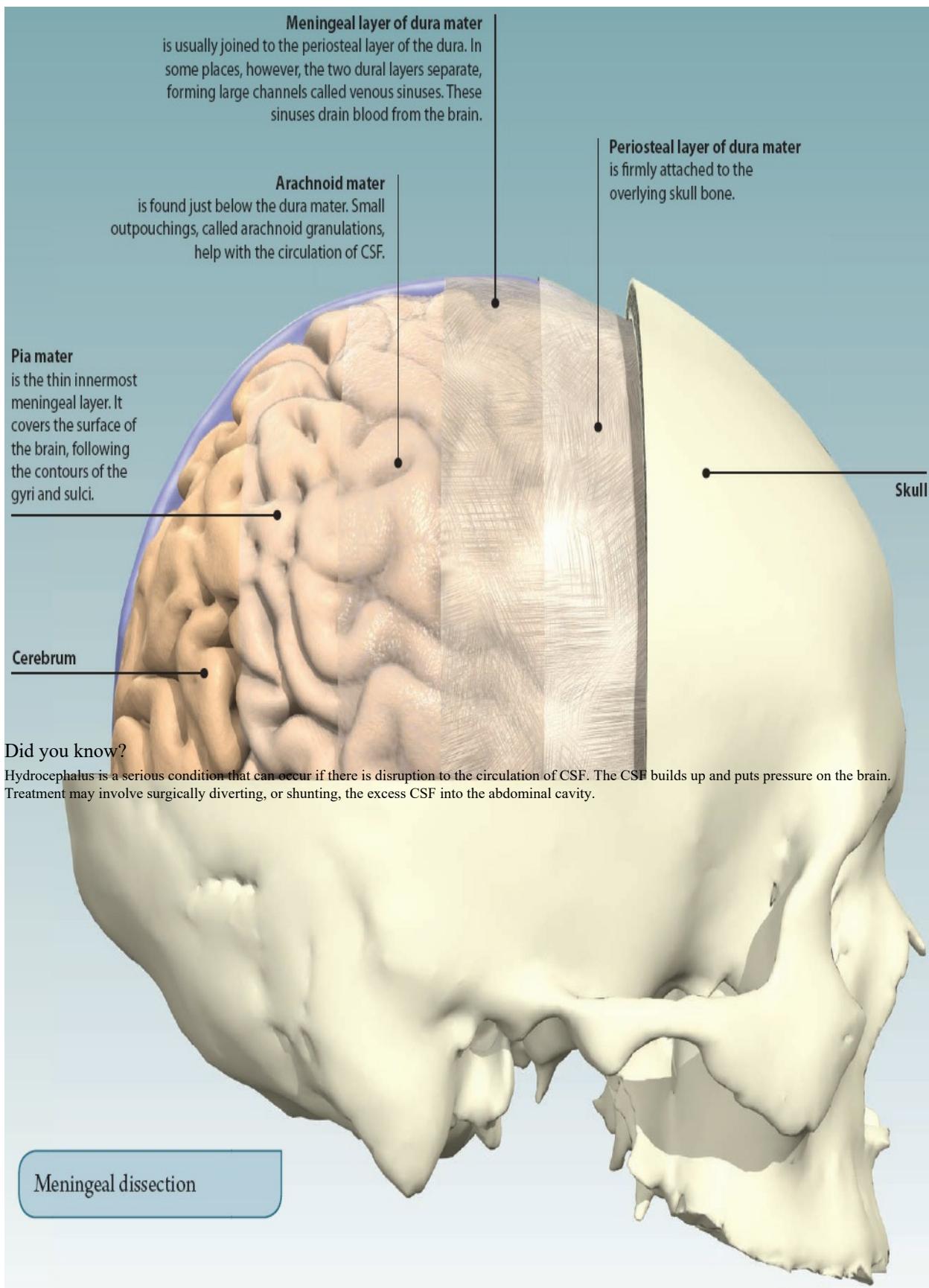


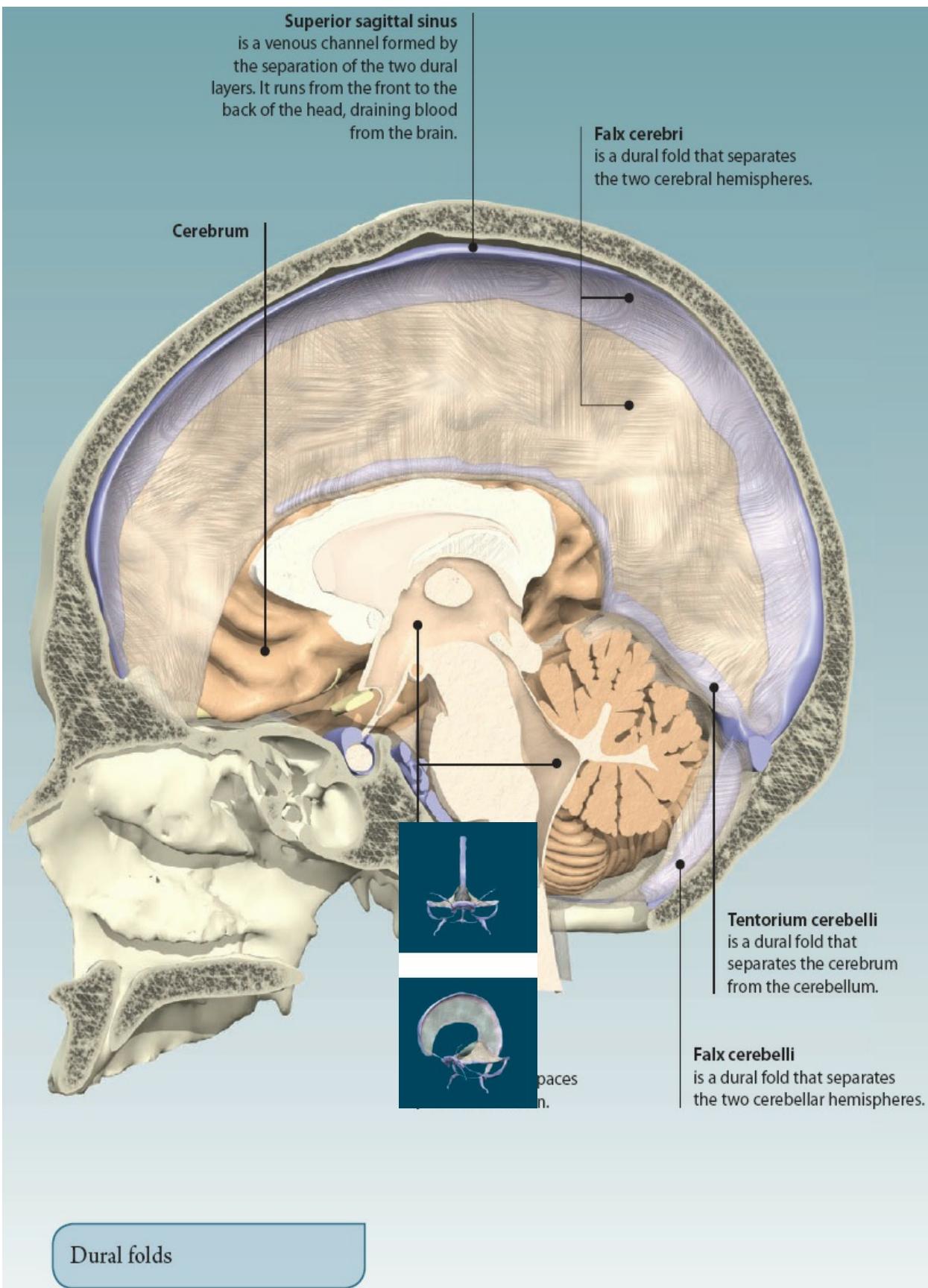


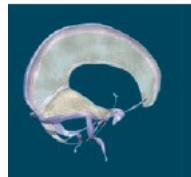
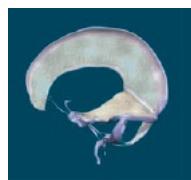
MENINGES AND CSF

The brain is separated from the bones of the skull by layers of fibrous tissue called the meninges. There are three meningeal layers: the dura mater, the arachnoid mater, and the pia mater. The dura mater is further divided into a periosteal and meningeal layer. Together, the meninges form a tough protective covering for the brain. In places the meningeal layer of the dura mater forms thickened folds, which separate parts of the brain, as well as providing support.

Cerebrospinal fluid (CSF) is produced in the ventricles. It bathes the brain, acting like a cushion, while also providing nutrition. It circulates in the subarachnoid space, found between the arachnoid and pia meningeal layers.



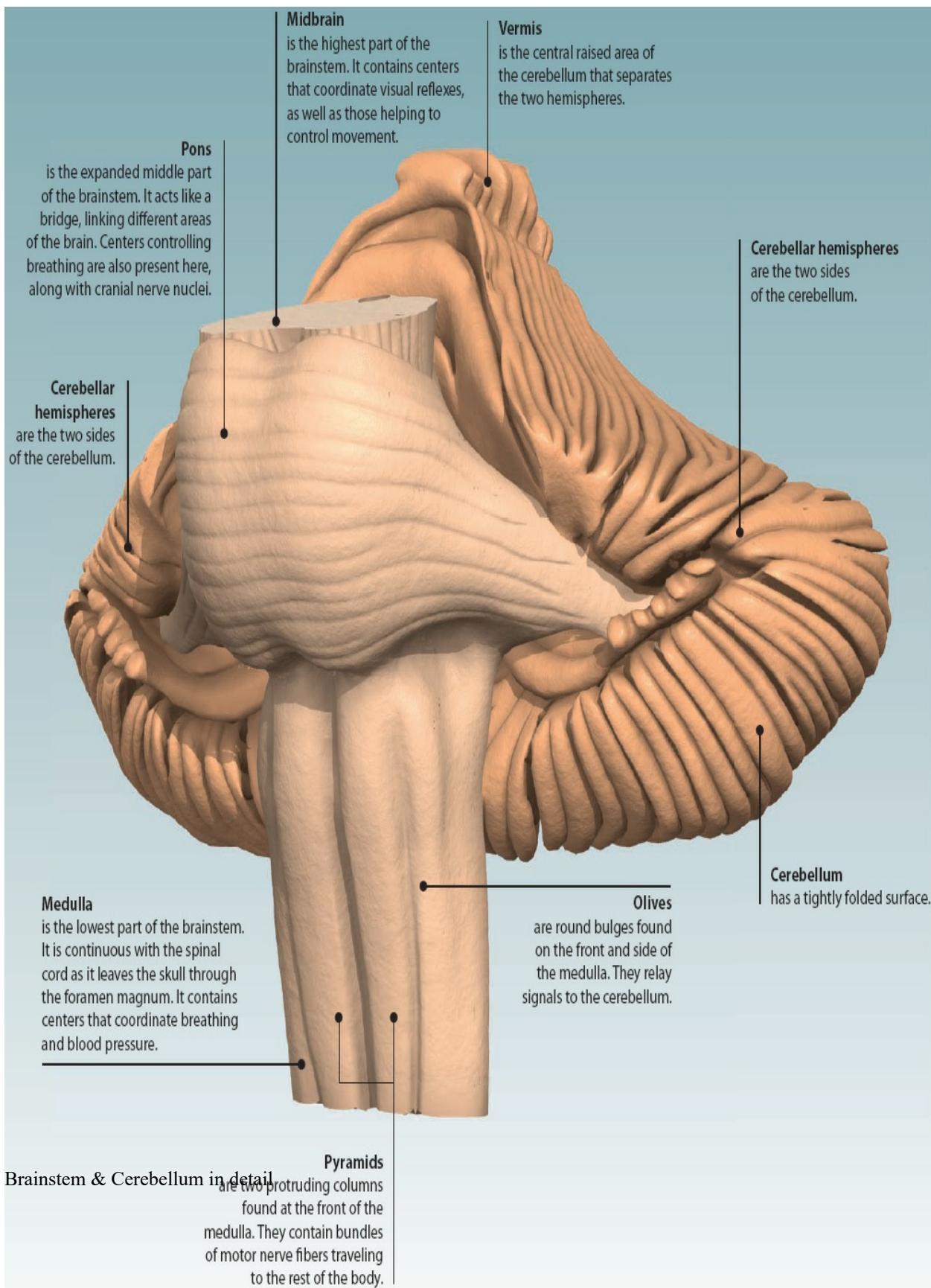


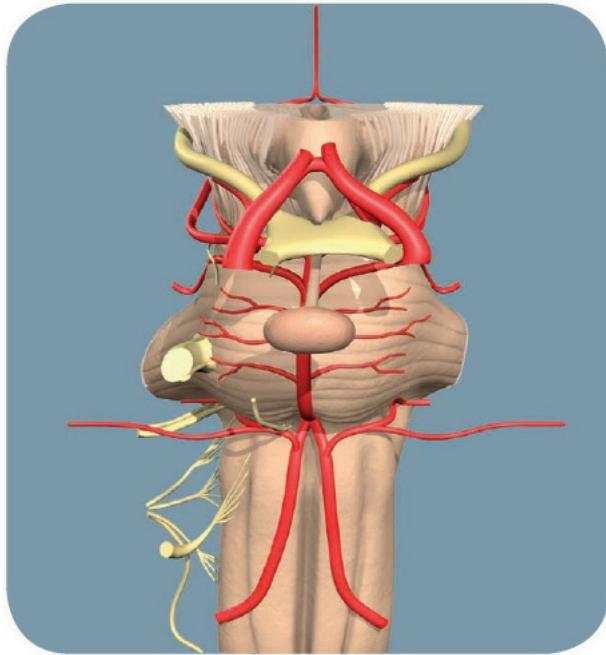


BRAINSTEM & CEREBELLUM

The brainstem connects the brain to the rest of the body. It consists of the midbrain, pons, and medulla. As well as containing all nerve fibers traveling to and from the spinal cord, the brainstem also has control centers for functions such as respiration (breathing), vomiting, and the control of blood pressure. It also contains the nuclei of the cranial nerves.

The cerebellum, or “little brain,” is located behind the brainstem. It helps to coordinate and fine tune movements, as well as contributing to balance. Via the brainstem, it has numerous connections with other areas of the brain.

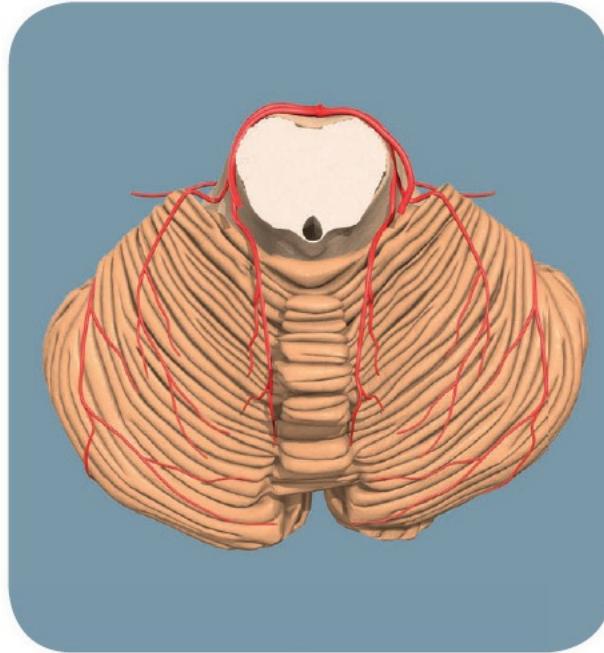




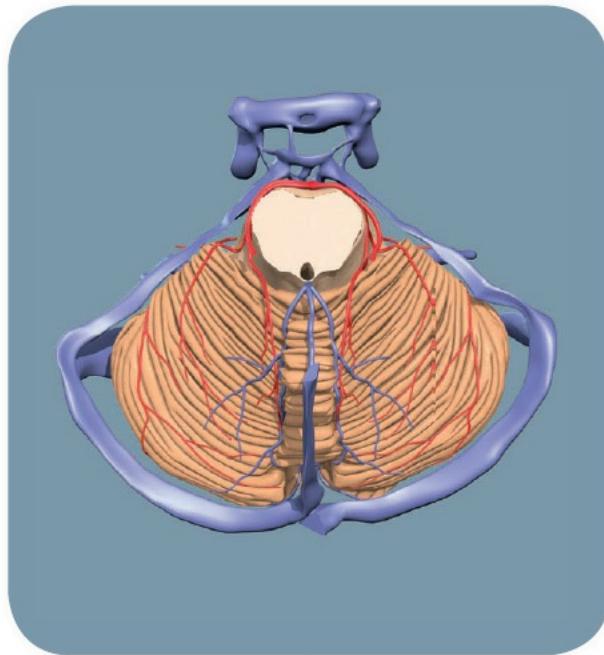
Arteries of the brainstem



Deep nuclei of the cerebellum



Arteries of the cerebellum



Vessels of the cerebellum

VENTRICLES OF THE BRAIN

The ventricles are interconnected, fluid-filled cavities within the brain. Specialized blood vessels in their walls produce cerebrospinal fluid (CSF), which circulates through the ventricles, before entering the subarachnoid space to bathe the surface of the brain. The CSF provides a cushion and support for the brain, as well as nutrition. There are four ventricles in total: two lateral, one third, and one fourth ventricle.

Curved Axial Section through the Brain

Septum pellucidum
is a thin piece of tissue
that separates the two
lateral ventricles.

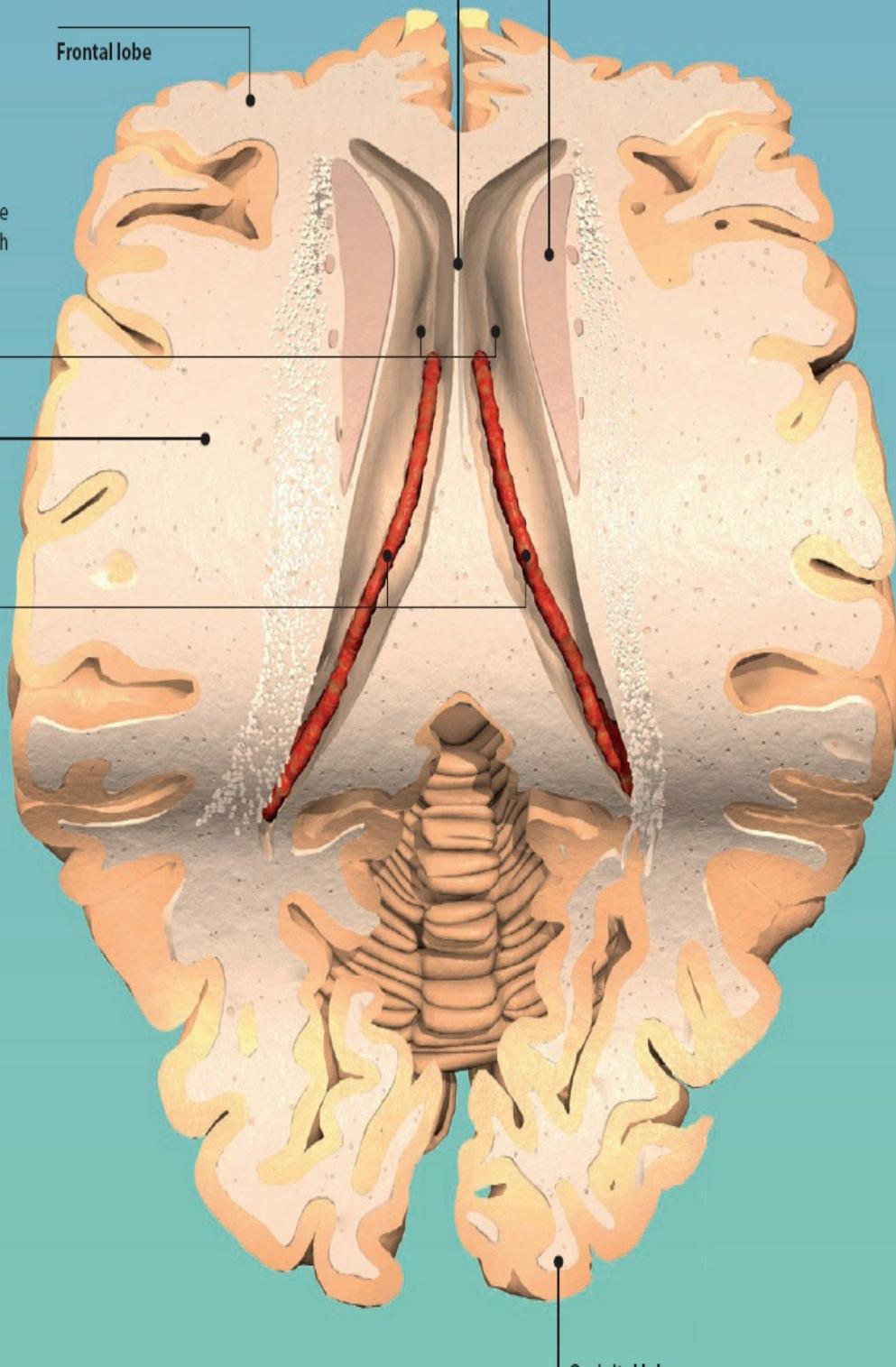
Caudate nucleus
is part of the basal ganglia.

Lateral ventricles
are found on each side of the
cerebrum. They connect with
the third ventricle through
small openings called the
interventricular foramina.

Cerebrum
forms the main part
of the brain.

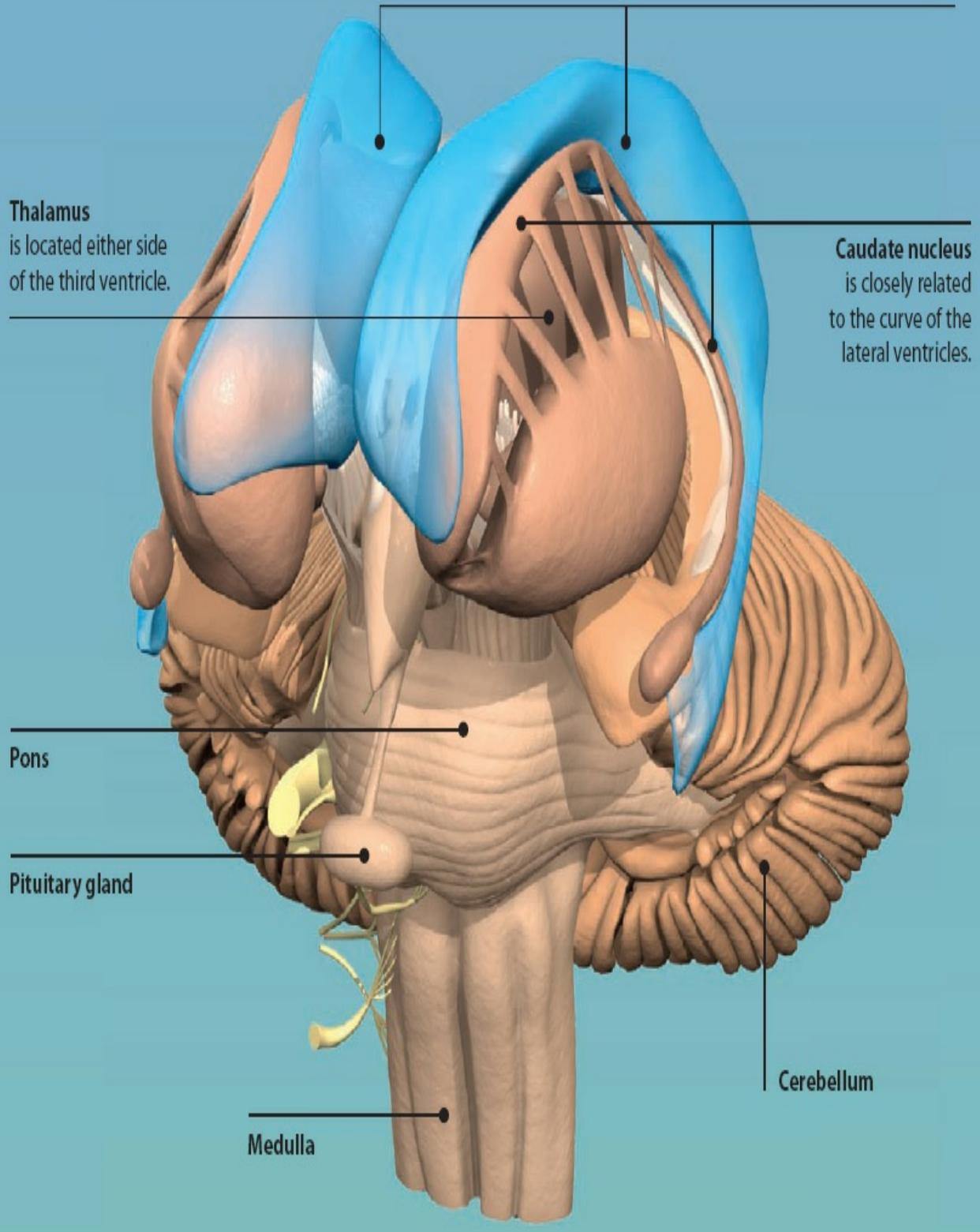
Choroid plexuses
are collections of
specialized capillaries
found within the walls
of the ventricles. They
produce cerebrospinal
fluid (CSF).

Occipital lobe

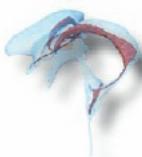
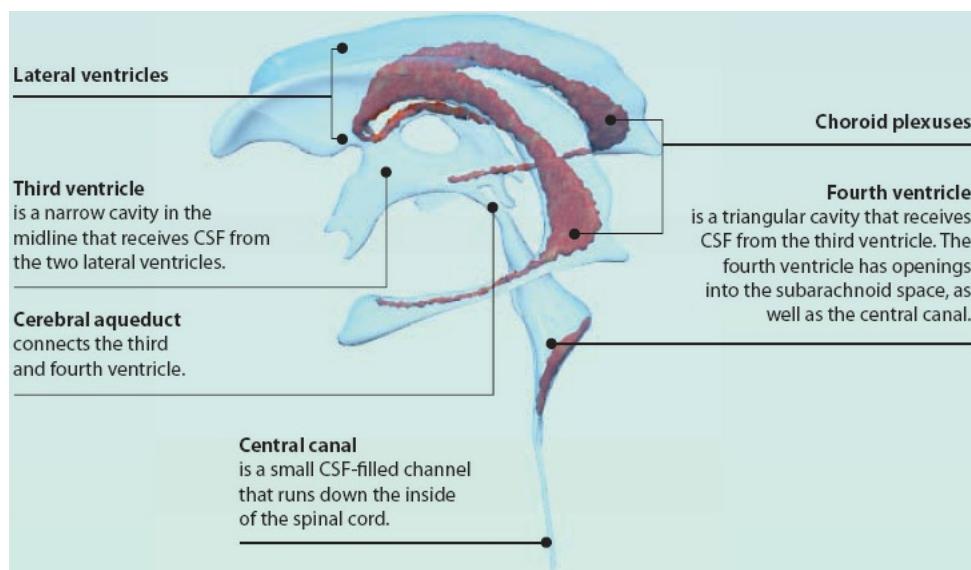


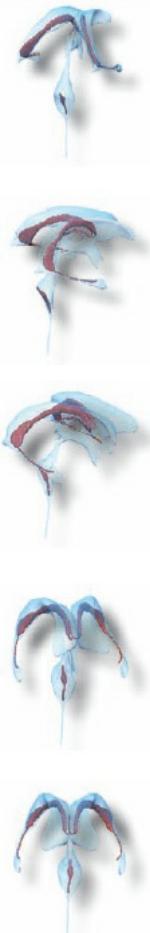
Ventricles and Thalamus

Lateral ventricles
are C-shaped cavities.



Ventricles in Isolation

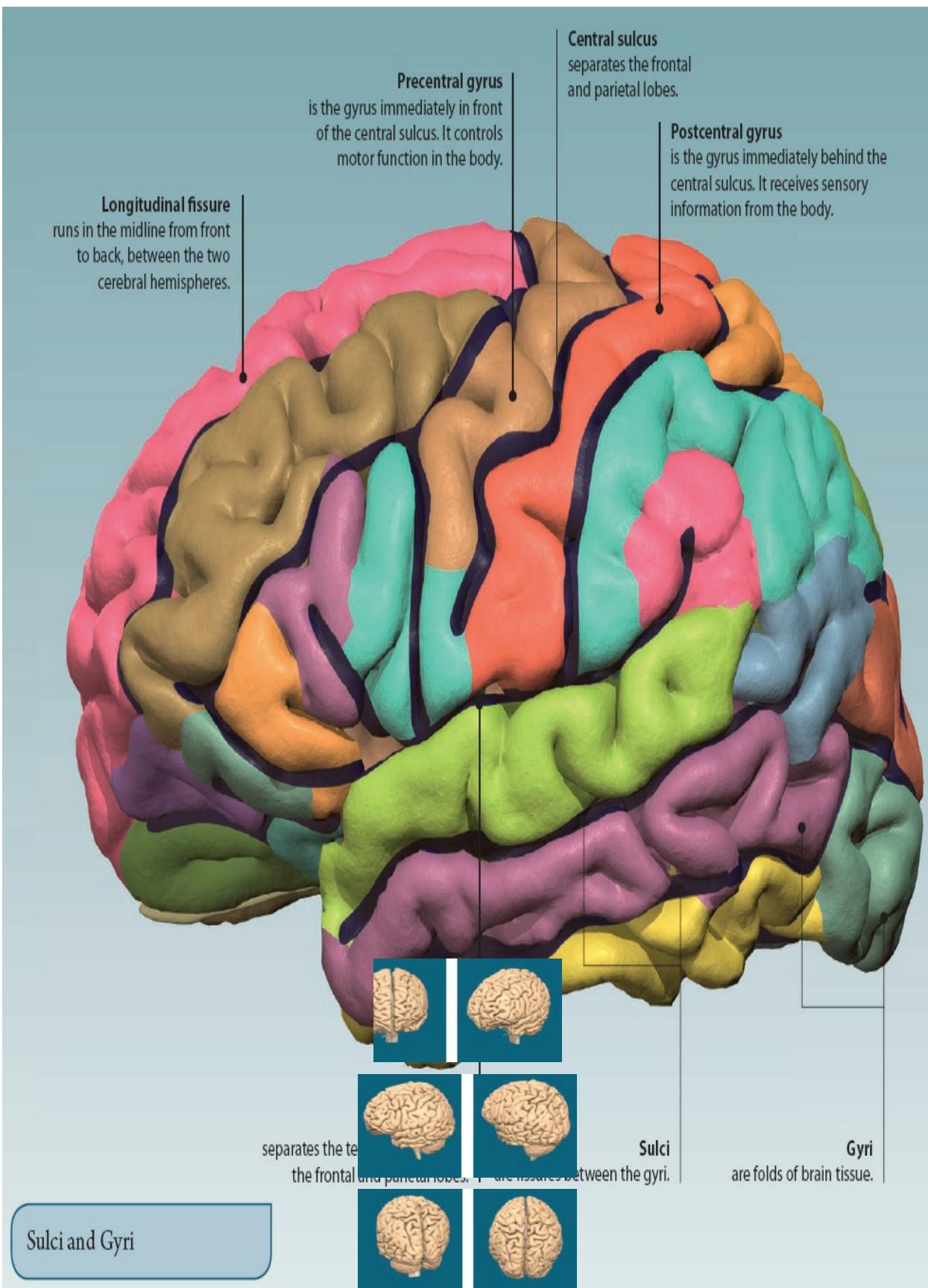


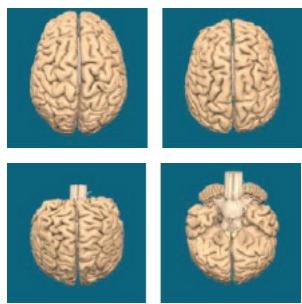


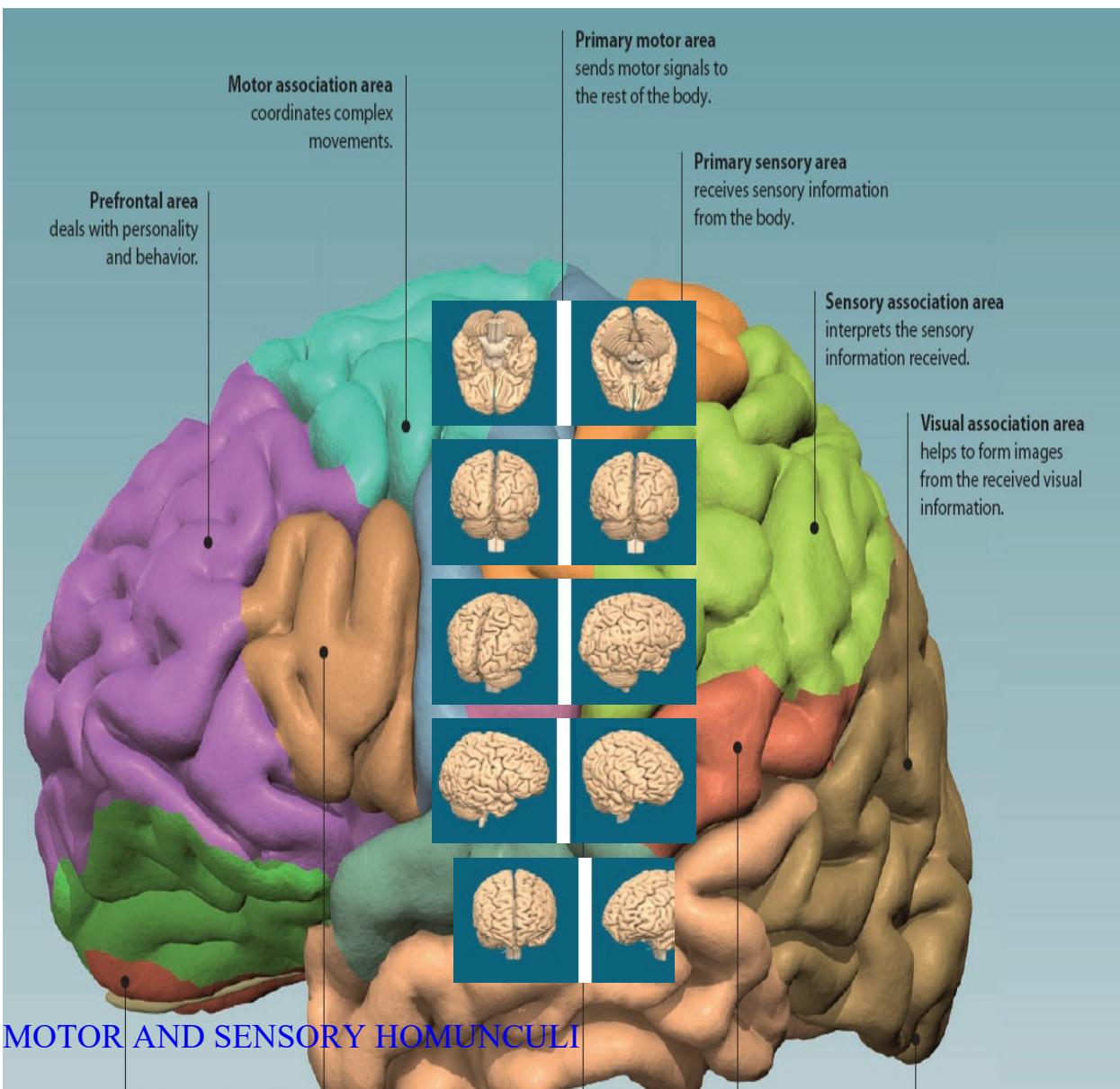
CEREBRUM

The outer surface of the cerebrum, containing the nuclei of nerve cells, is called the cortex. It is tightly folded to increase the amount of nervous tissue that can be packed into the cranial cavity. It forms gyri (folds) and sulci (fissures between the folds). Some of these gyri and sulci are used to divide the brain up into different areas.

The cerebrum organizes many of the complex functions of the brain, including movement, touch, and pain sensation, speech, hearing, and vision. Different areas of the brain carry out these specific functions. Primary areas receive or send the nerve signals. Association areas help modify or interpret the nerve signals.





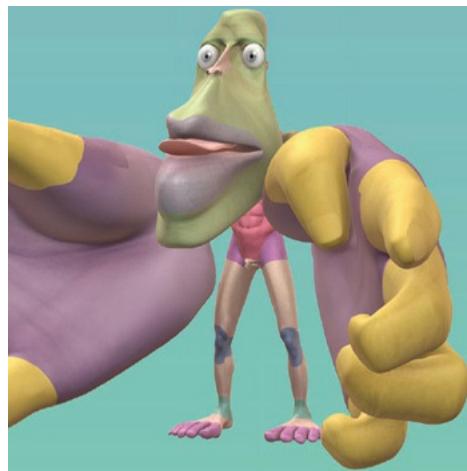
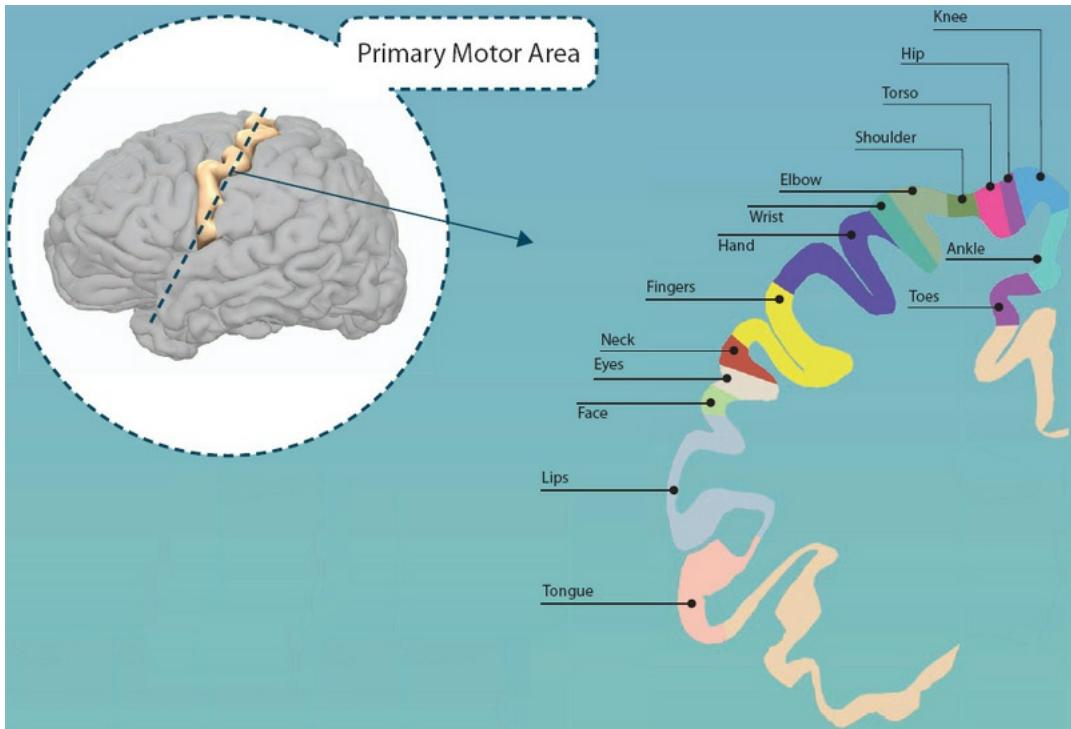


MOTOR AND SENSORY HOMUNCULI

The primary **motor and sensory** areas of the brain are organized in such a way that each part of the body is represented by a **specific region** on these strips of cerebral cortex. The size of the cortex which represents the body part is a reflection of how many motor or sensory nerves supply that region.

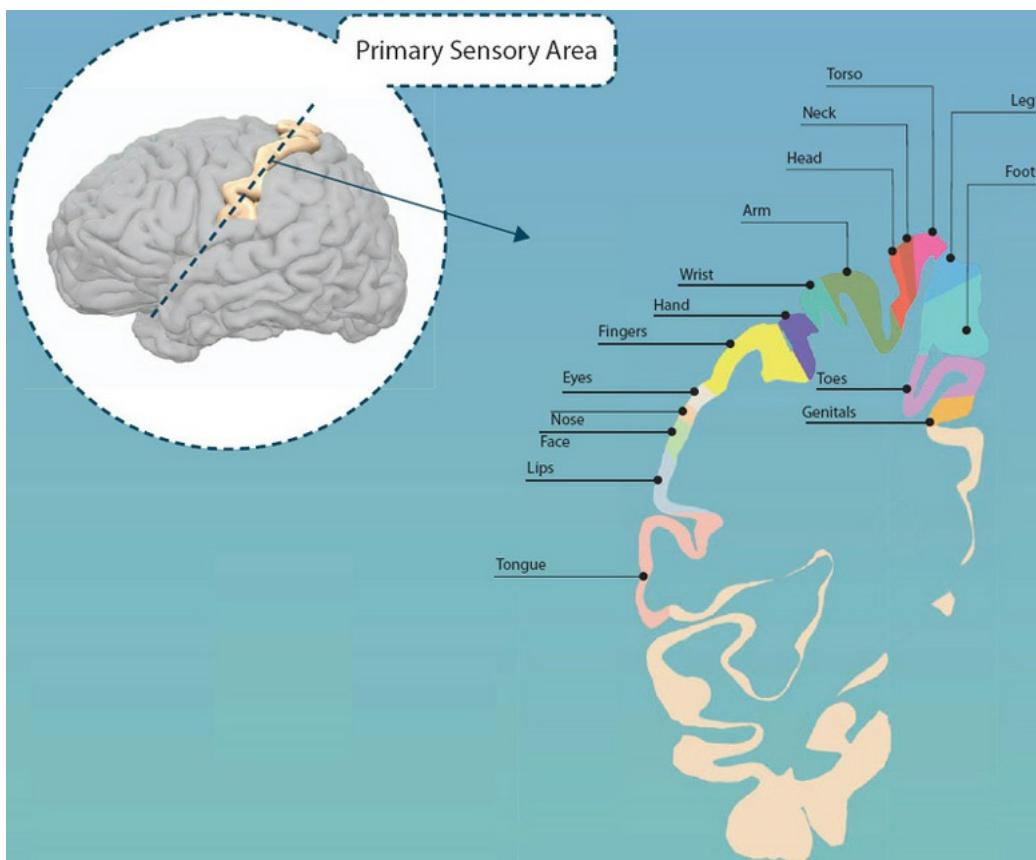
Homunculi (little humans) are representations of the entire human body. However, each body part is drawn on a scale corresponding to the size of the cortex and number of nerves which supply them, rather than their actual physical size. This creates **distorted characters** which give a graphic representation of the amount of cortex allocated to each body part. Both motor and sensory homunculi can be created to express speech.

Cortical Areas of the Cerebrum



Motor homunculus

has a relatively large tongue, lips and hands. This reflects the large number of motor nerves supplying the muscles in these regions. This is necessary to help with the fine control and coordination required in these regions for actions such as speech, swallowing, manipulating, and grasping objects.



Sensory homunculus

has a relatively large head, hands, and sex organs. This reflects the large number of sensory nerves supplying these regions. By contrast, the trunk and lower limbs are relatively small in comparison.

BASAL GANGLIA AND CONNECTING FIBERS

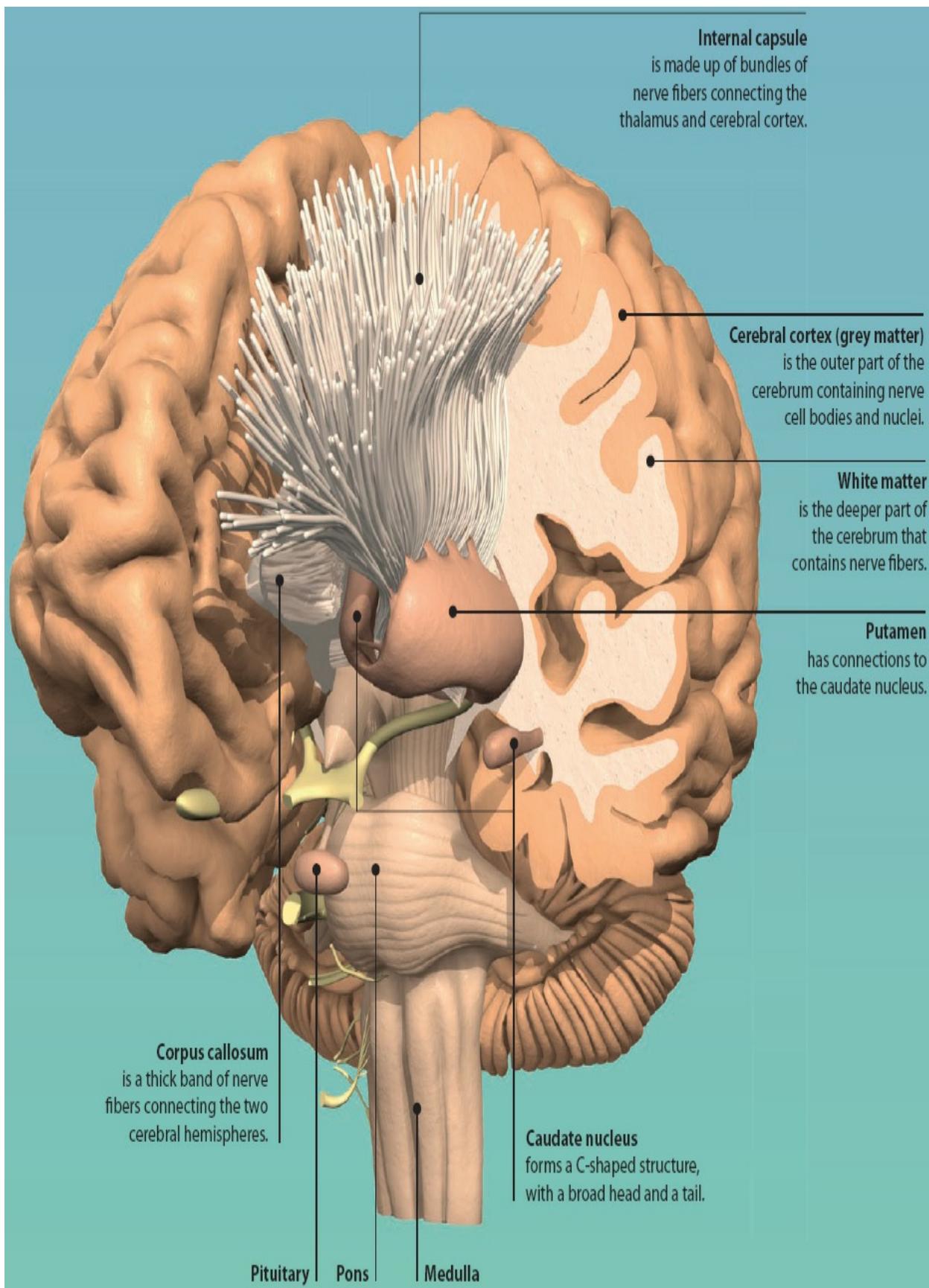
The basal ganglia are collections of nerve cell nuclei, located deep within the cerebrum. The three distinct areas are known as the caudate nucleus, putamen, and globus pallidus. Their main role is in coordinating and controlling body movements. They also influence muscle tone and body posture.

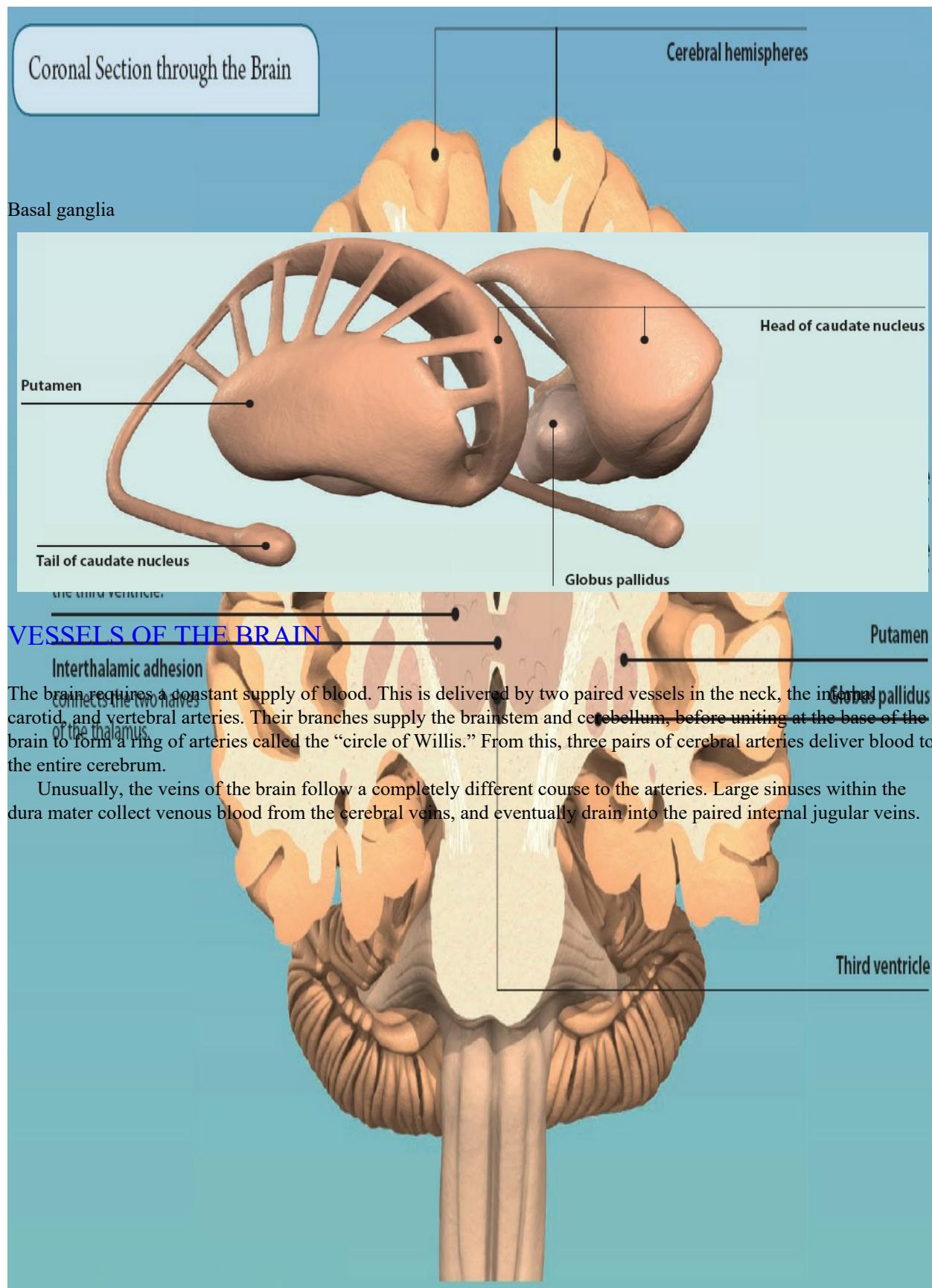
The thalamus is a large collection of nerve cell nuclei located between the brainstem and the cerebrum, close to

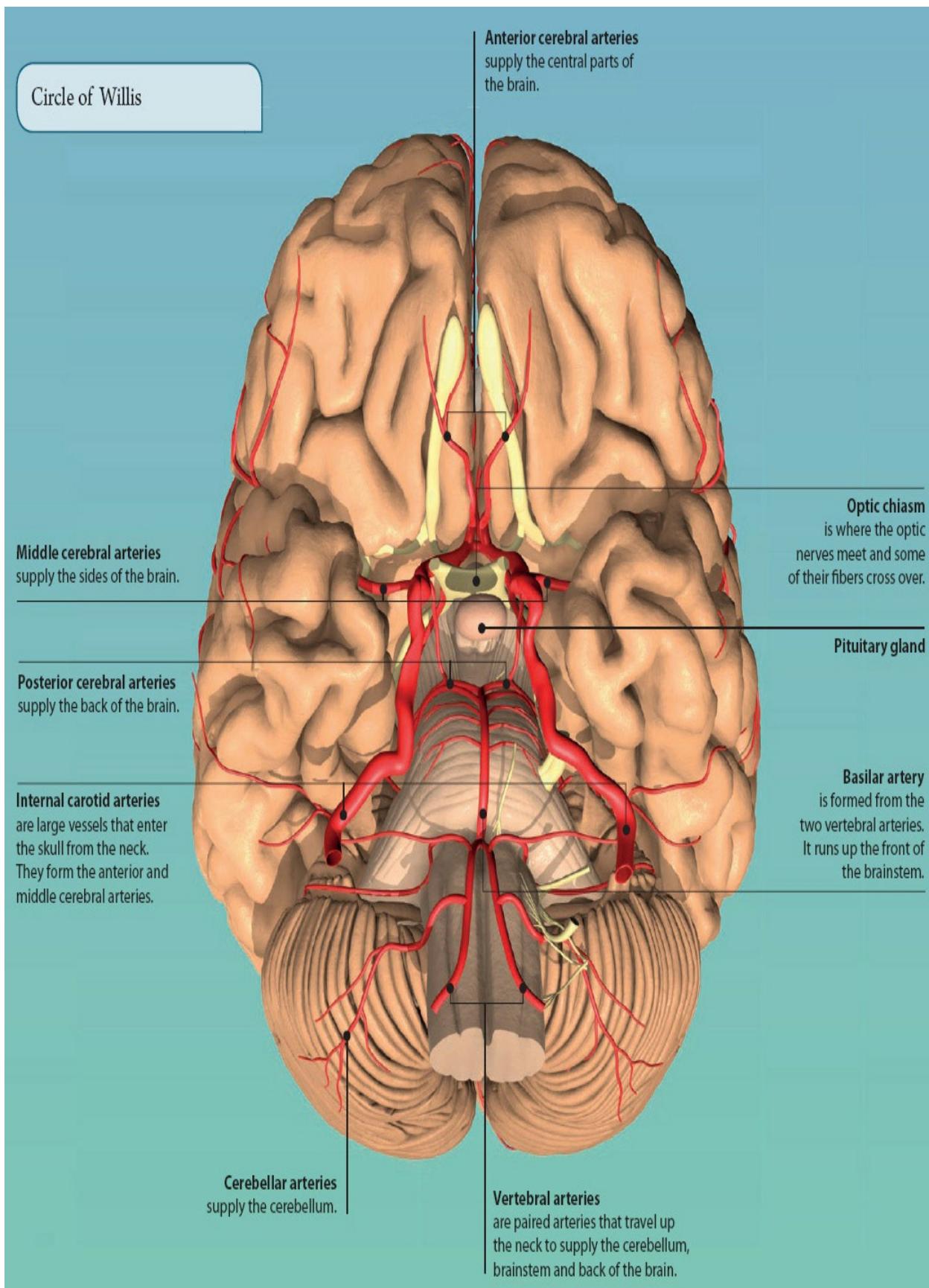
the basal ganglia. It is a relay center for the many nerve fibers passing between the cerebral cortex (outer part of the cerebrum) and the brainstem. Connecting fibers running to the cerebral cortex form a band known as the internal capsule.

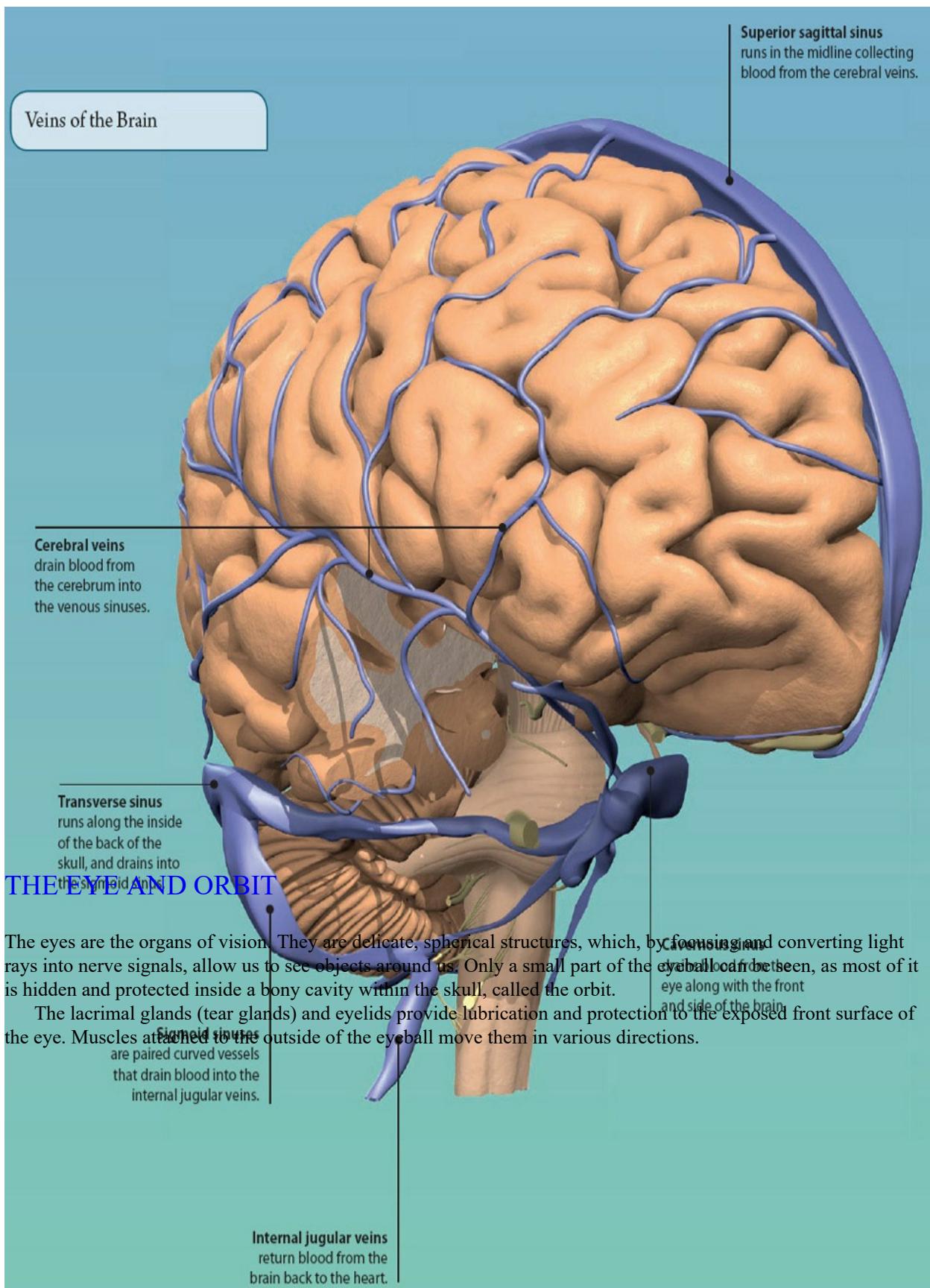
Did you know?

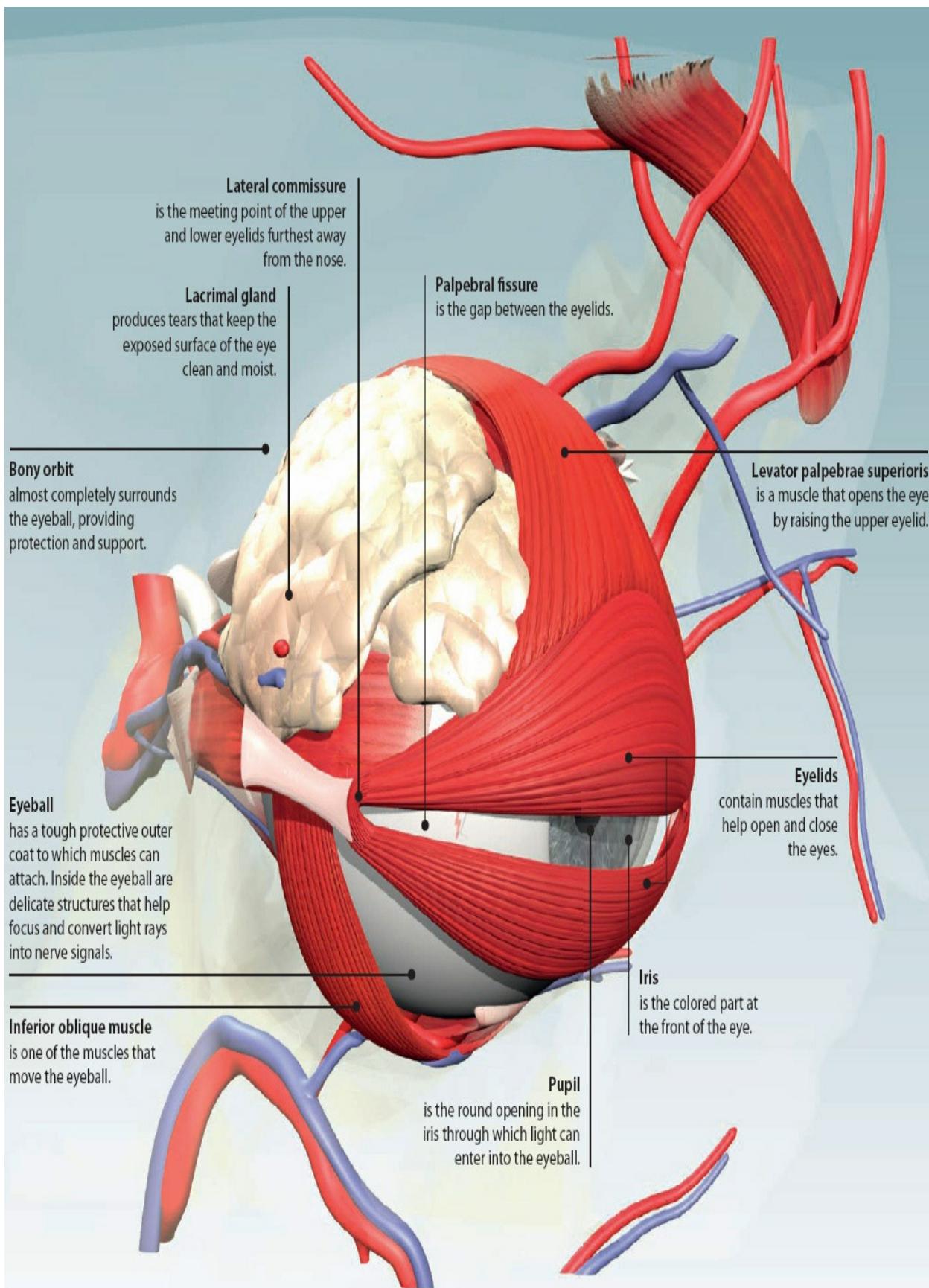
Parkinson's disease is a relatively common nervous system disease which affects the basal ganglia. It is caused by the loss of nerve fibers which release a substance called dopamine. Patients often have a tremor and have difficulty starting movements.



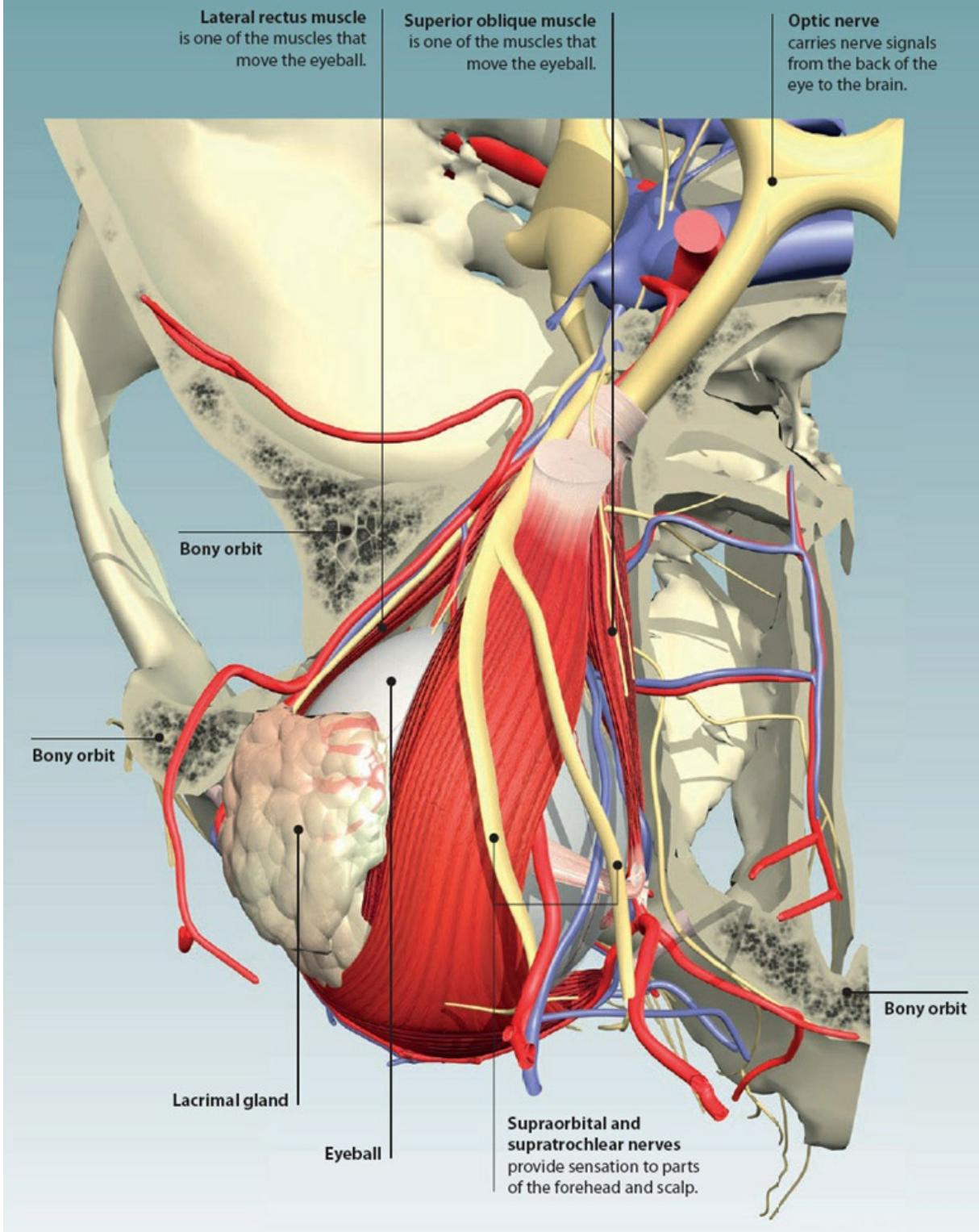


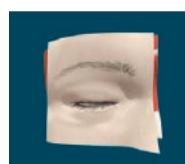
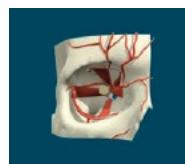
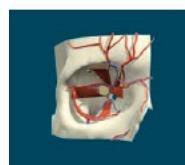
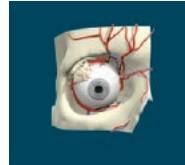
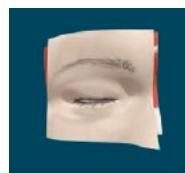






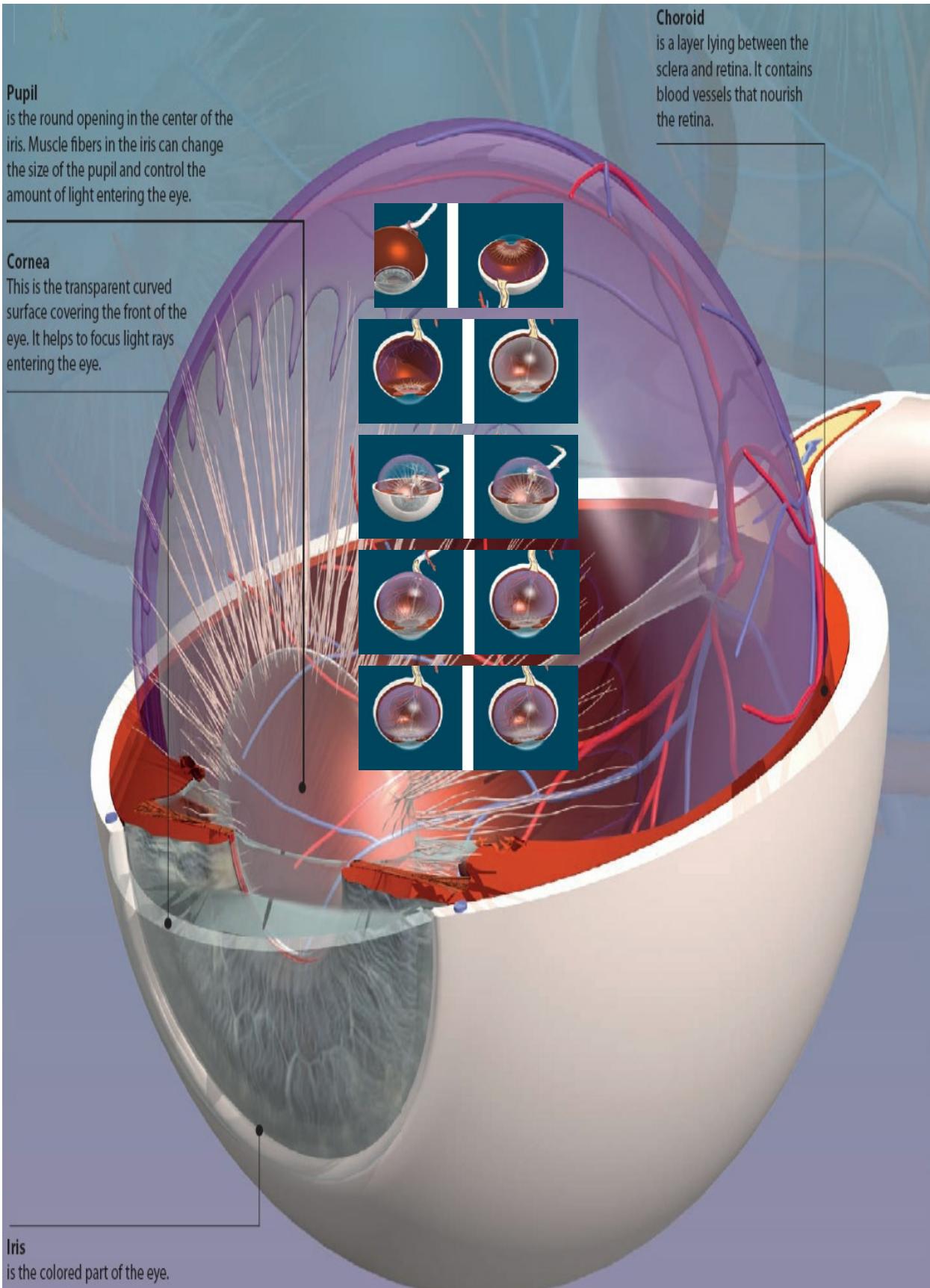
Orbit from above





INTERNAL STRUCTURES OF THE EYE

The eye is often compared to a camera. It has an opening at the front to vary the amount of light that enters it (iris), structures to focus the light rays (cornea and lens), and a light sensitive area (retina) to receive the focused image. It has a tough protective outer coat (sclera) and a “power supply” that provides its structures with blood and nutrients (choroid). There is even a “cable” (optic nerve) that “downloads” images formed on the retina directly to the part of the brain which interprets them.



The Eye

Ciliary body

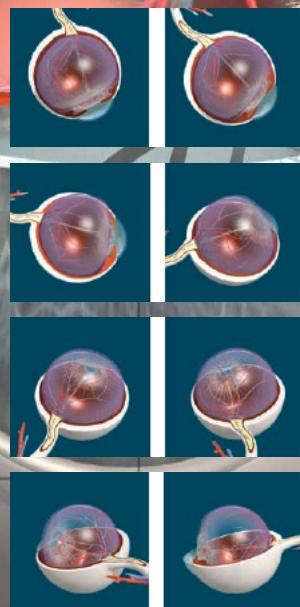
produces a watery fluid called aqueous humor, which circulates in the anterior cavity.

Posterior cavity

is the area behind the lens. It contains a thick jelly like material called the vitreous humor.

Retina

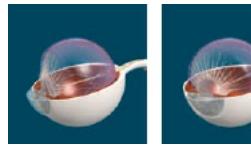
is a layer of specialized nerve cells lining the back and inside of the eye. It converts light rays into a signal that can be sent to the brain via the optic nerve.



Lens

is a clear flexible structure that is suspended behind the iris by suspensory ligaments attached to the ciliary body. It focuses light rays to form a clear image on the retina.

Sclera (or "white of the eye") is the tough, protective outer layer that covers the entire eye, except the cornea.

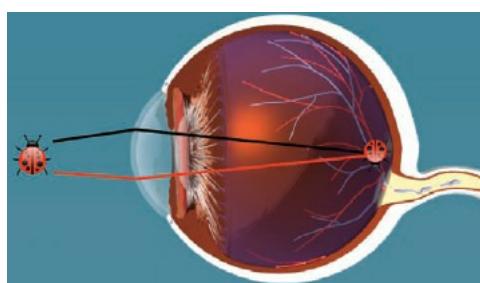


VISION

Vision is probably our most important sense. It allows us to identify different colored objects, over a range of distances, in both bright and dark light conditions. The retina lines most of the inside of the eye. It converts light rays from an object into an electrical signal that can be sent to the brain for processing. The retina is made up of a number of layers, most of which are formed by different types of nerve cells.

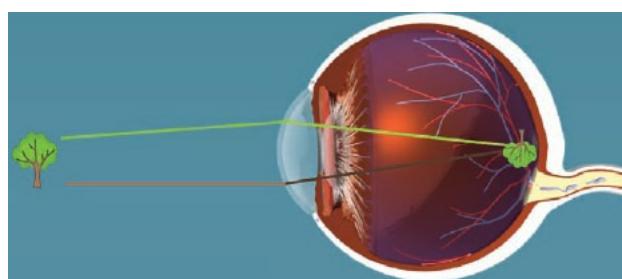
Accommodation

Viewing near objects



To allow us to focus light rays from near objects, the lens has to change shape and become more spherical. This process is called accommodation.

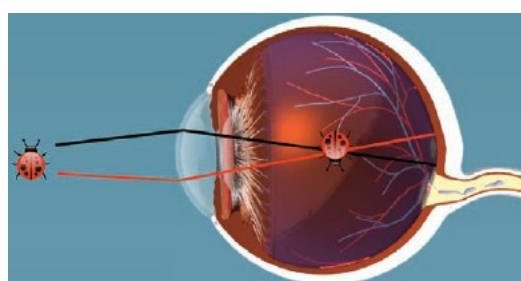
Viewing distant objects



Light rays entering the eye are bent and focused by the lens and cornea in a process called refraction. This forms a sharp image on the retina.

Refraction Abnormalities

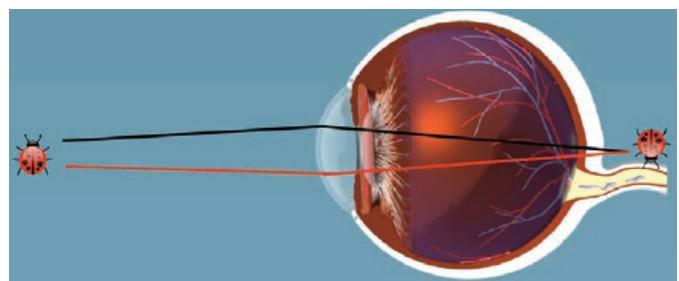
Myopia (short sightedness)



Disorders that affect the ability to produce a focused image on the retina are common, and are called refraction abnormalities. They can usually be treated with glasses or contact lenses.

Myopia (short sightedness) occurs when the image is focused in front of the retina.

Hyperopia (long sightedness)



Hyperopia (long sightedness) occurs when the image is focused behind the retina.

Microanatomy of the Retina

Amacrine cells

and horizontal cells help 'fine tune' the signal before it leaves the retina.

Bipolar cells

receive the electrical signals from the photoreceptors.

Ganglion cells

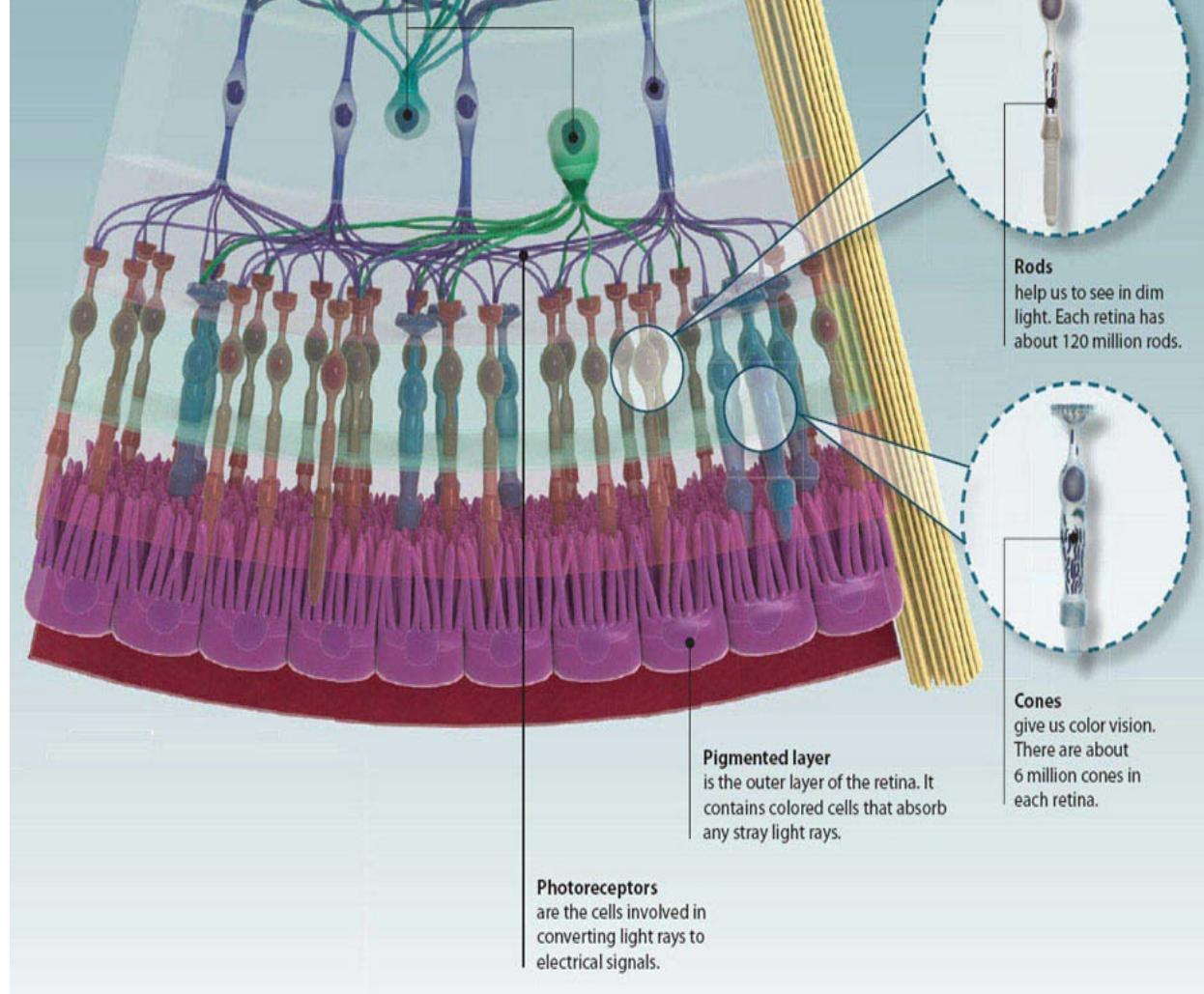
from all over the retina group together and leave the eye as the optic nerve. The signal is then passed along the visual pathway to those parts of the brain that interpret visual information.

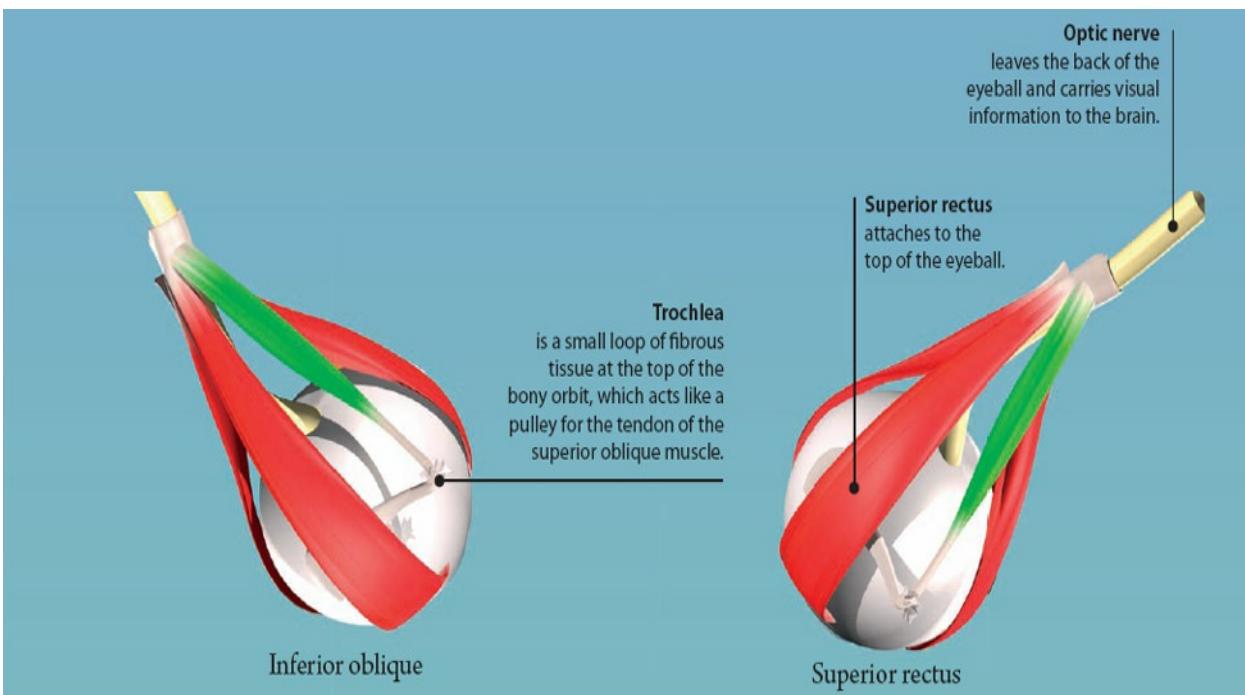
LASIK—Laser-Assisted In-Situ Keratomileusis

LASIK is a simple surgical procedure that can be used to correct refraction abnormalities, without the need for glasses or contact lenses. A special laser reshapes the cornea so that light rays are focused on the retina.

EXTRINSIC EYE MUSCLES

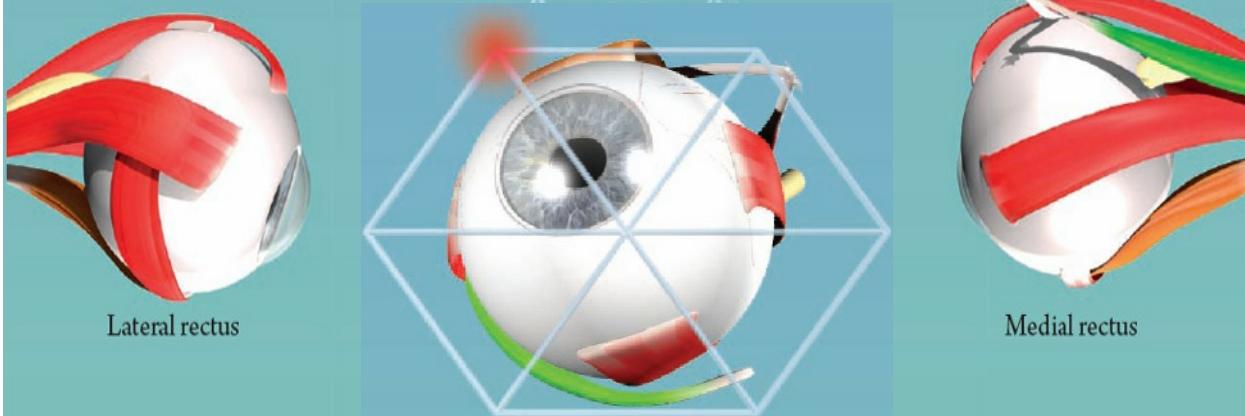
Six small muscles coordinate the rapid and precise movements of the eyeball. They allow us to follow objects through a wide range of motion, without us having to constantly move our head. They are all attached from the walls of the bony orbit to the tough white outer part of the eyeball, called the sclera. They get their nerve supply from cranial nerves III, IV, and VI.





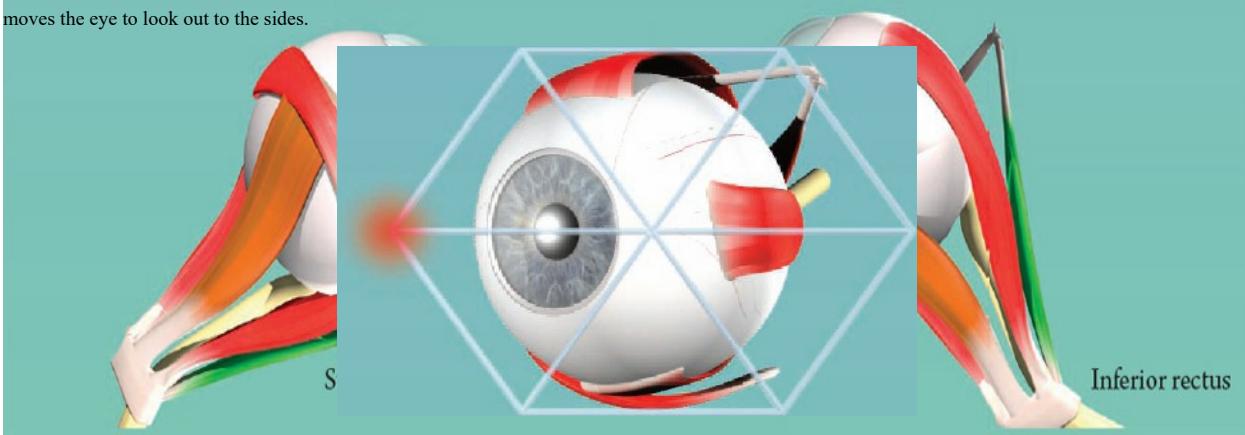
Inferior Oblique

rotates the eye to look up and out to the side.



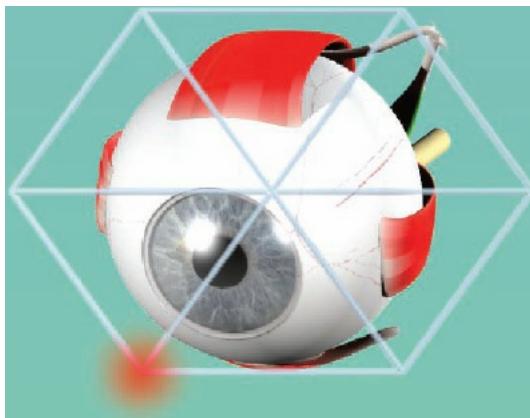
Lateral Rectus

moves the eye to look out to the sides.



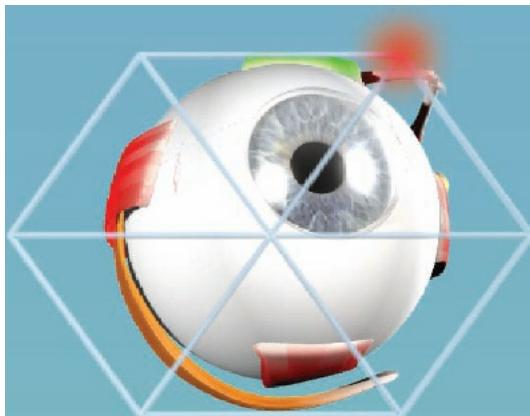
Superior Oblique

rotates the eye to look down and out to the side.



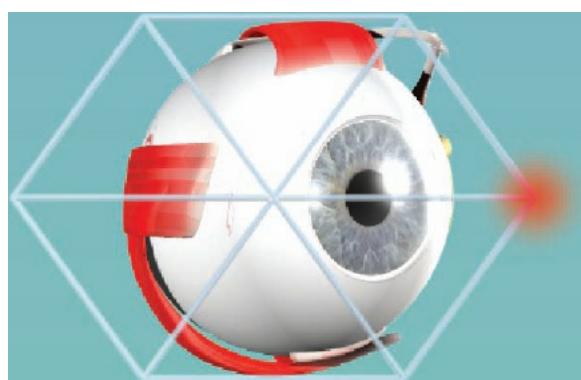
Superior Rectus

moves the eye to look up and in towards the nose.



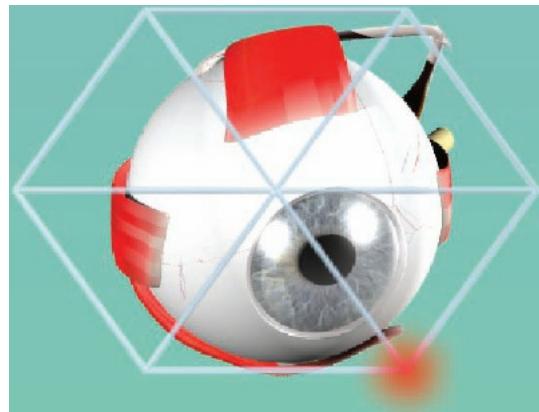
Medial Rectus

moves the eye to look towards the nose.



Inferior Rectus

moves the eye to look down and in towards the nose.

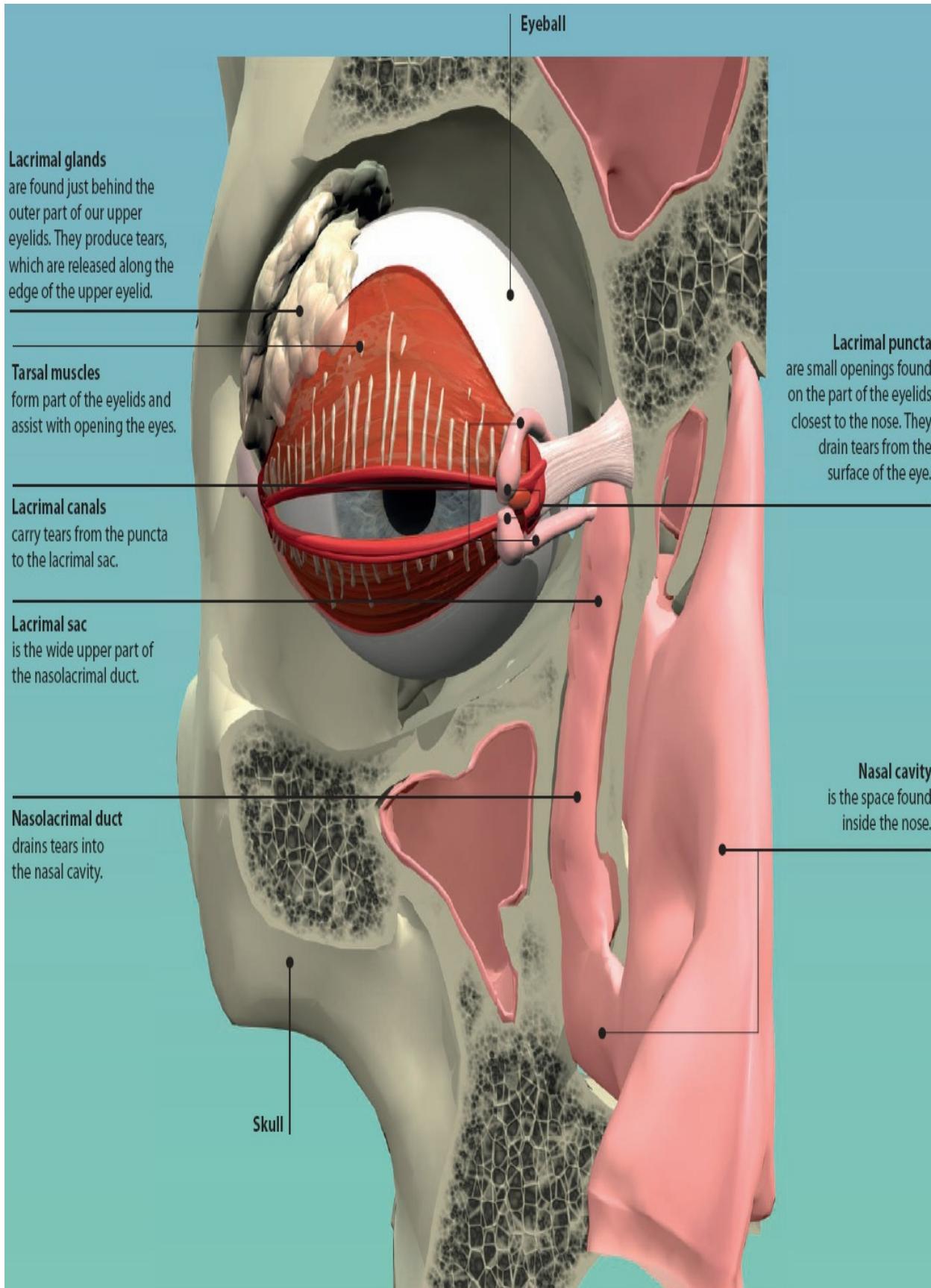


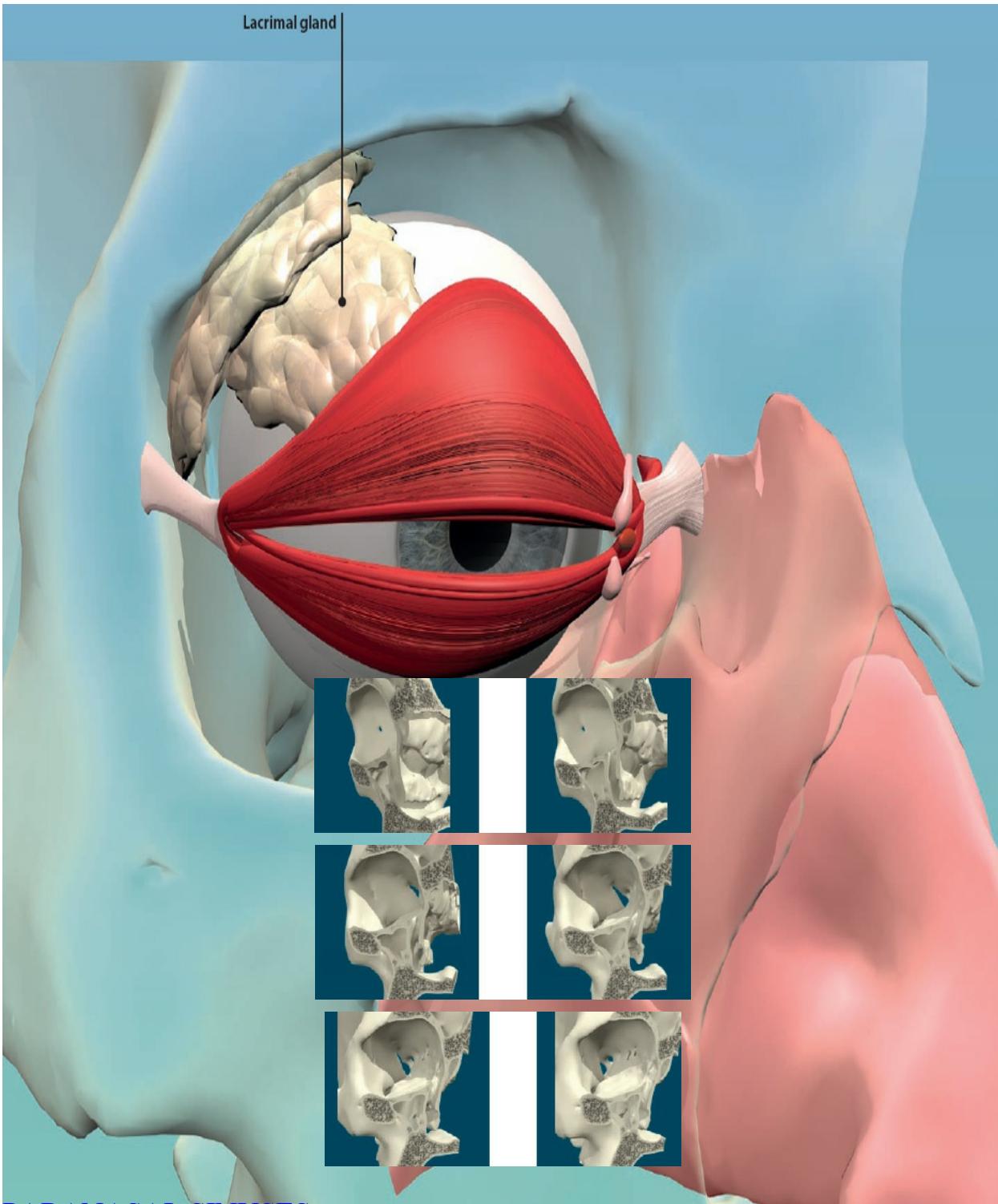
LACRIMAL APPARATUS

The lacrimal apparatus is a collection of structures involved with the production and drainage of tears. Tears are made by the lacrimal glands, and help moisturize and protect the surface of the eye. When we blink, or close our eyes, tears are swept across the surface of the eye towards the nose. The tears then drain via small openings on our eyelids (puncta), into a channel that leads eventually into the nose (nasolacrimal duct). This explains why, when we cry, our nose often runs as well.

Did you know?

The average rate of blinking is about 10 times per minute in adults. This reduces to about 3-4 times per minute when reading or concentrating on a screen, and can lead to sore eyes, as they are less moisturized and start to dry out.





PARANASAL SINUSES

The paranasal sinuses are air-filled cavities, found within the bones of the skull around the nose. There are four groups of sinuses: the maxillary, frontal, ethmoid, and sphenoid. They are connected to the nasal cavity, and lined by the same cells, producing a mucuslike secretion. This helps to moisten the air being breathed in, as well as trapping any particles. The main function of the paranasal sinuses is to reduce the weight of the skull. In addition, they also

act like echo chambers and contribute to the sound of the voice.

Paranasal Sinuses

Ethmoid sinuses
are small irregular cavities found between the eyes.

Skull

Frontal sinuses
are found in the middle of the forehead, above and between the eyes.

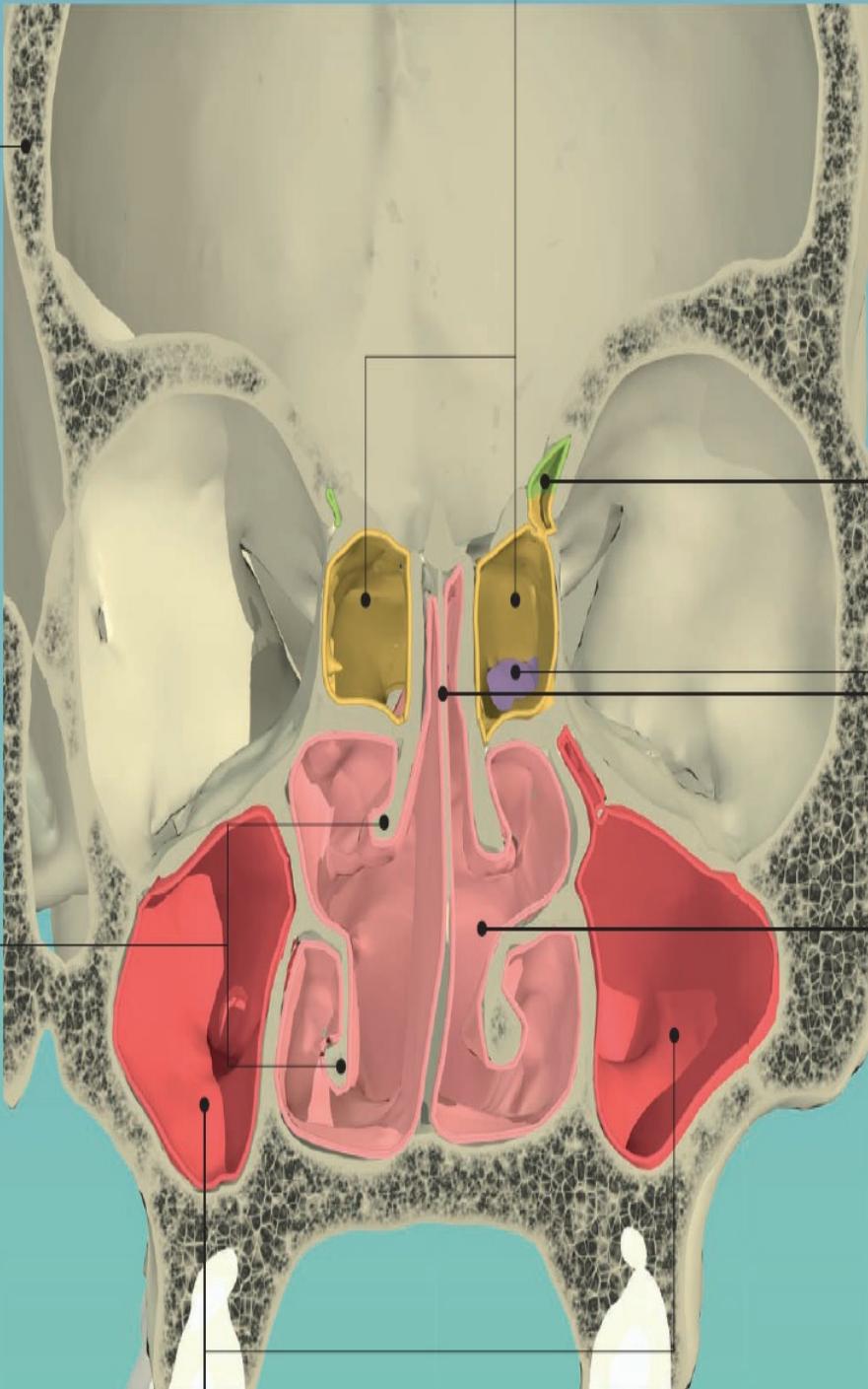
Sphenoid sinuses
are located behind the ethmoid sinuses, within the sphenoid bone.

Nasal septum
divides the nasal cavity into two halves.

Nasal conchae
are curved shelves of bone found within the nasal cavity.

Nasal cavity
is the space found inside the nose.

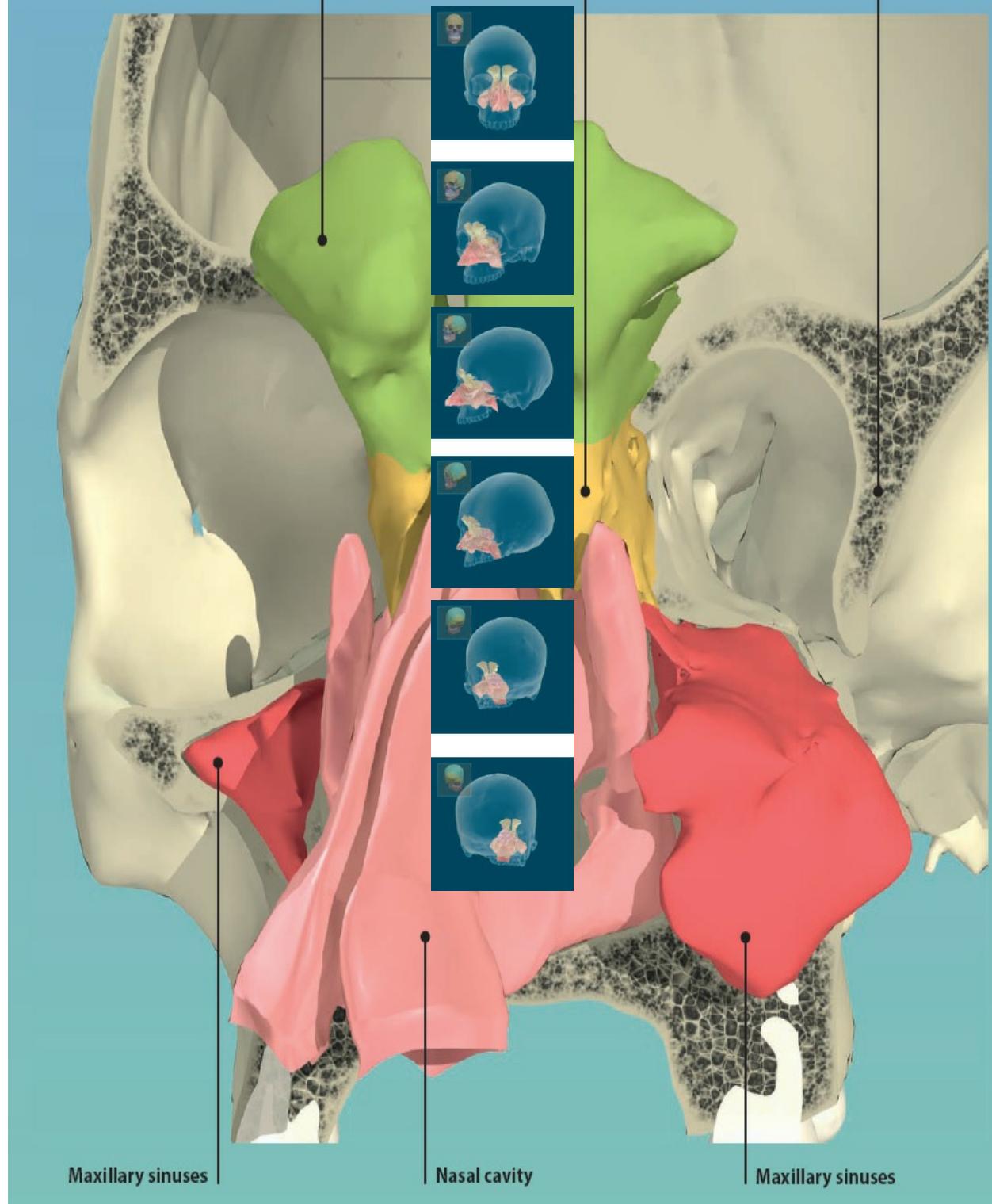
Maxillary sinuses
are paired cavities located in either side of the nose, beneath the eyes.

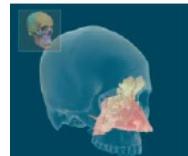
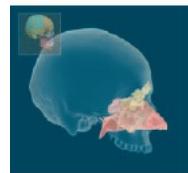
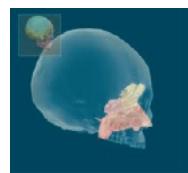


Coronal Section

Sinusitis

Inflammation of the cells lining the paranasal sinuses is called sinusitis. It can occur following infection with a virus or bacteria. Symptoms include headache, raised temperature, and nasal stuffiness. There may also be tenderness of the face around the nose. Treatments can include nasal sprays, decongestants, pain killers, and sometimes antibiotics.

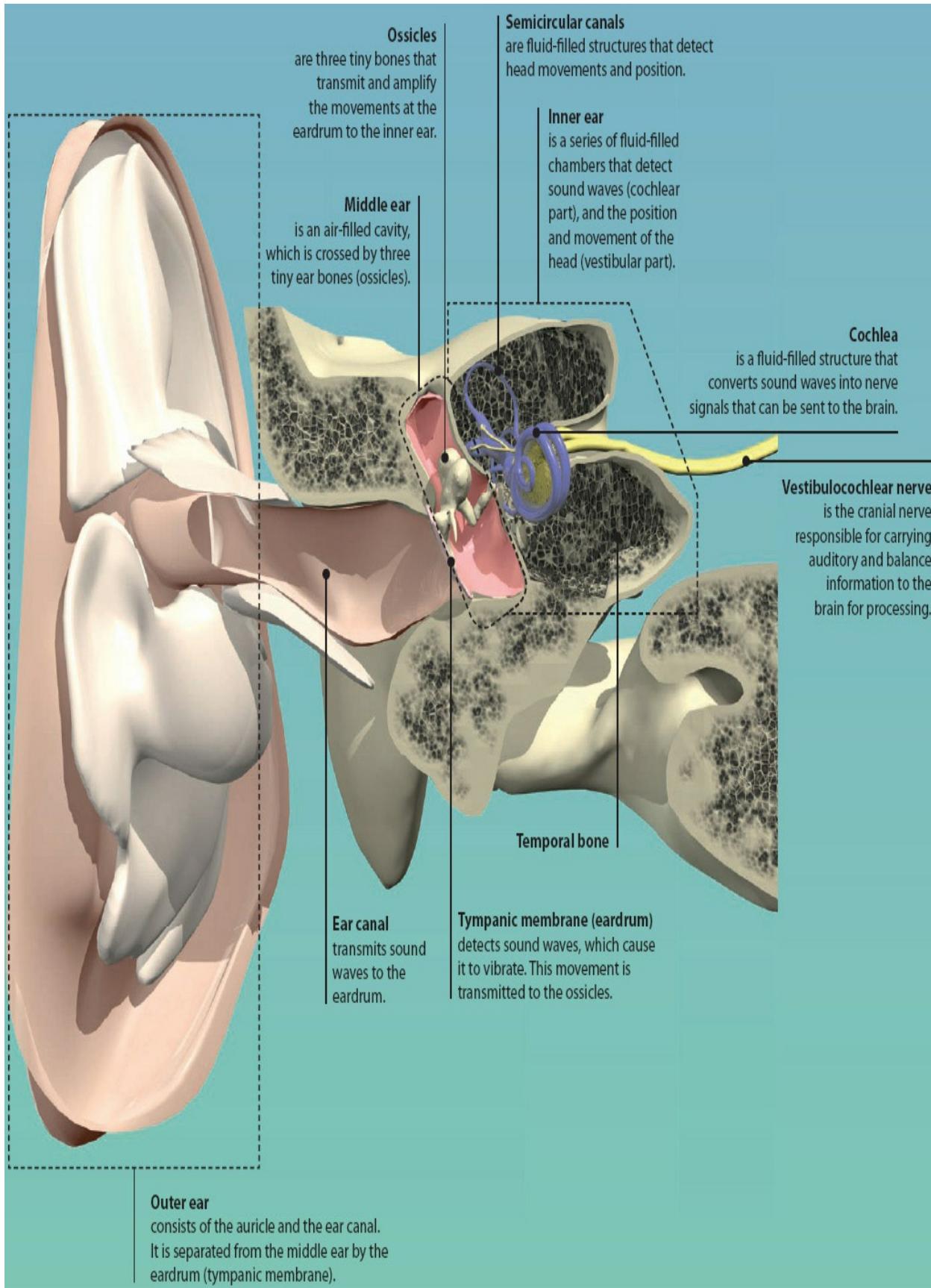


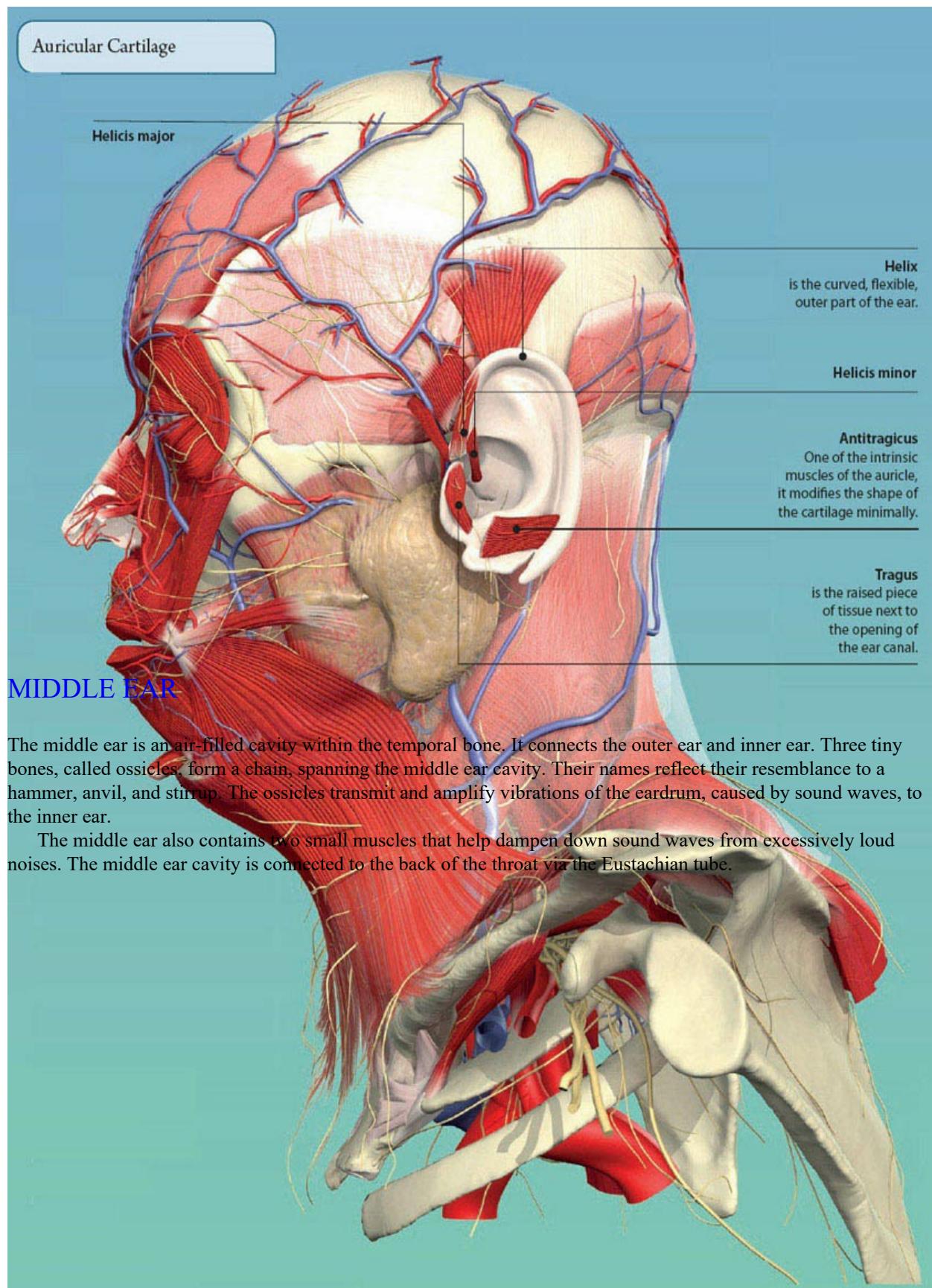


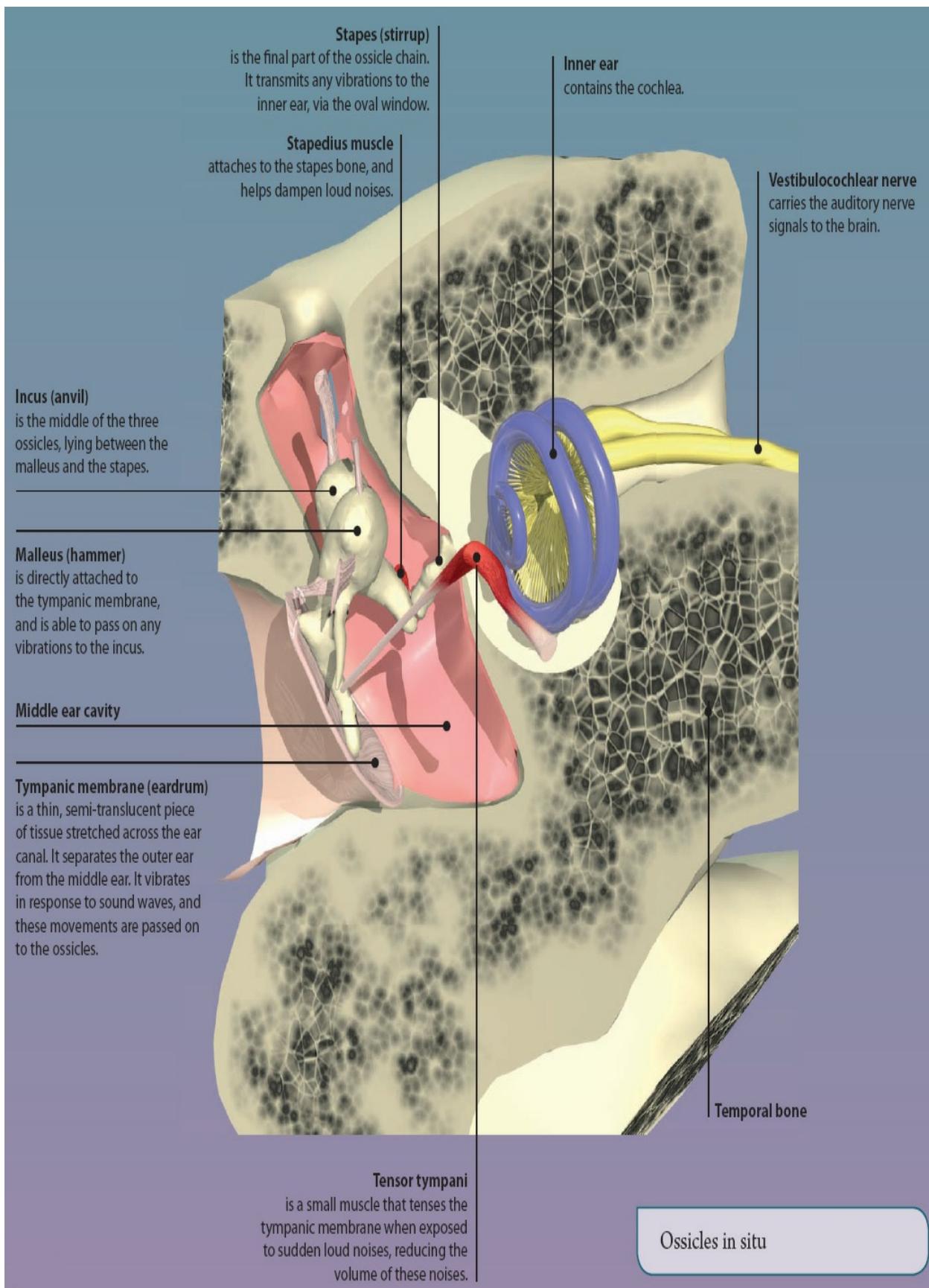
THE EAR

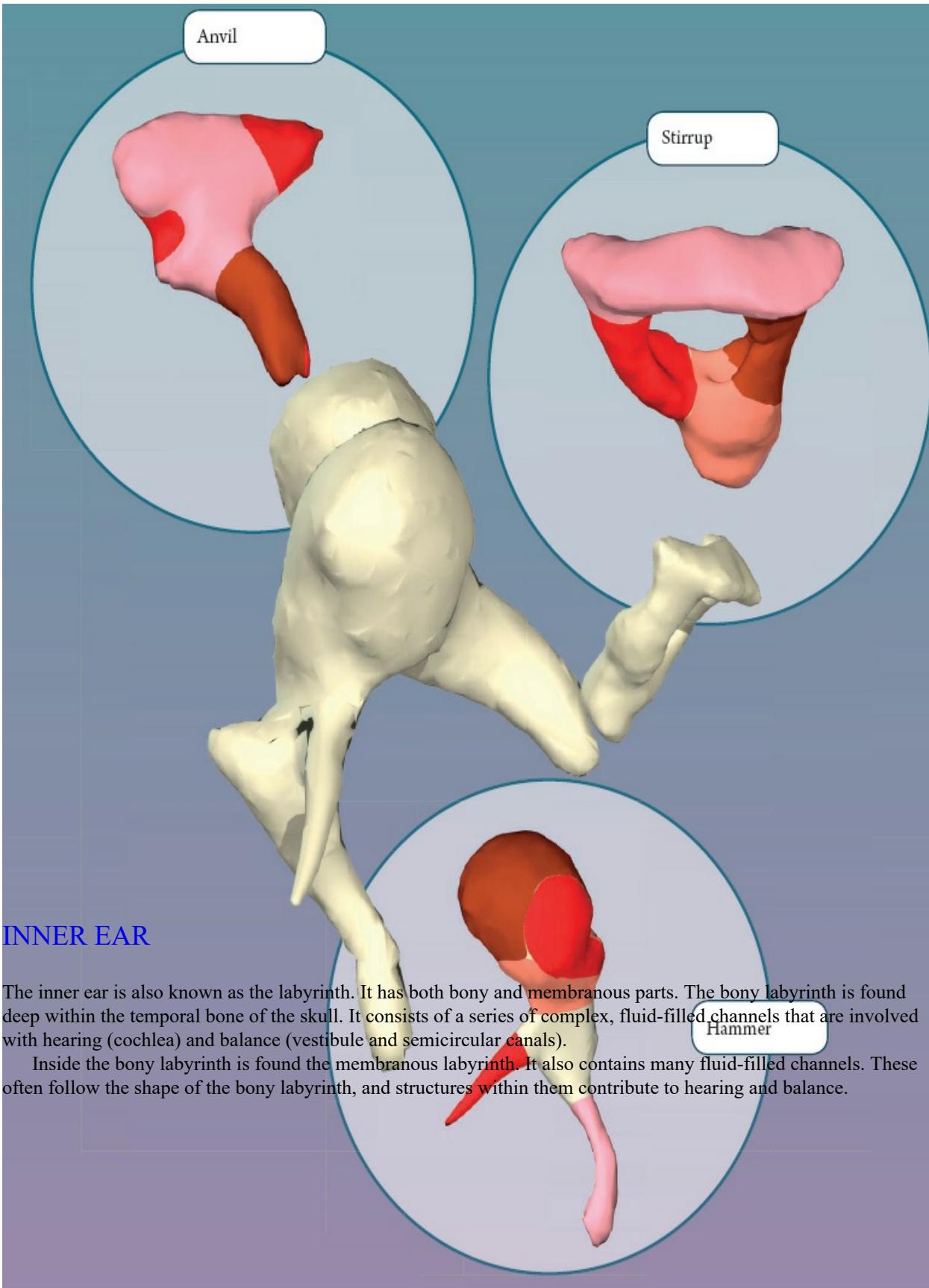
The ear is the organ of hearing and balance. Most of it is hidden from view, protected within the temporal bone of the skull. The ear is divided into three regions: outer, middle, and inner.

The hearing part of the ear detects sound waves over a wide range of frequencies and volumes, and sends nerve signals to the auditory parts of the brain to be interpreted. The balance (or vestibular) part of the brain detects movement and position of the head.







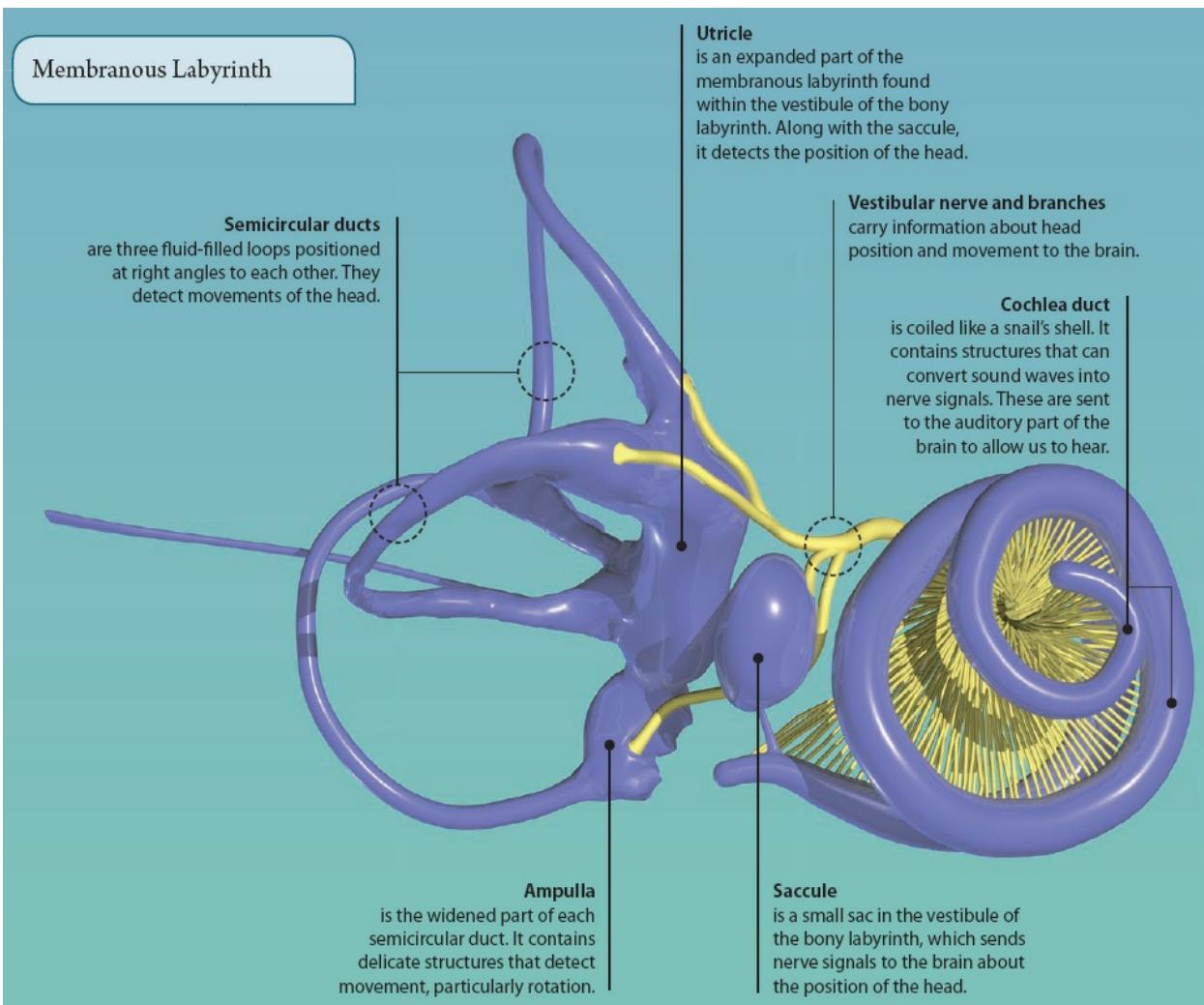


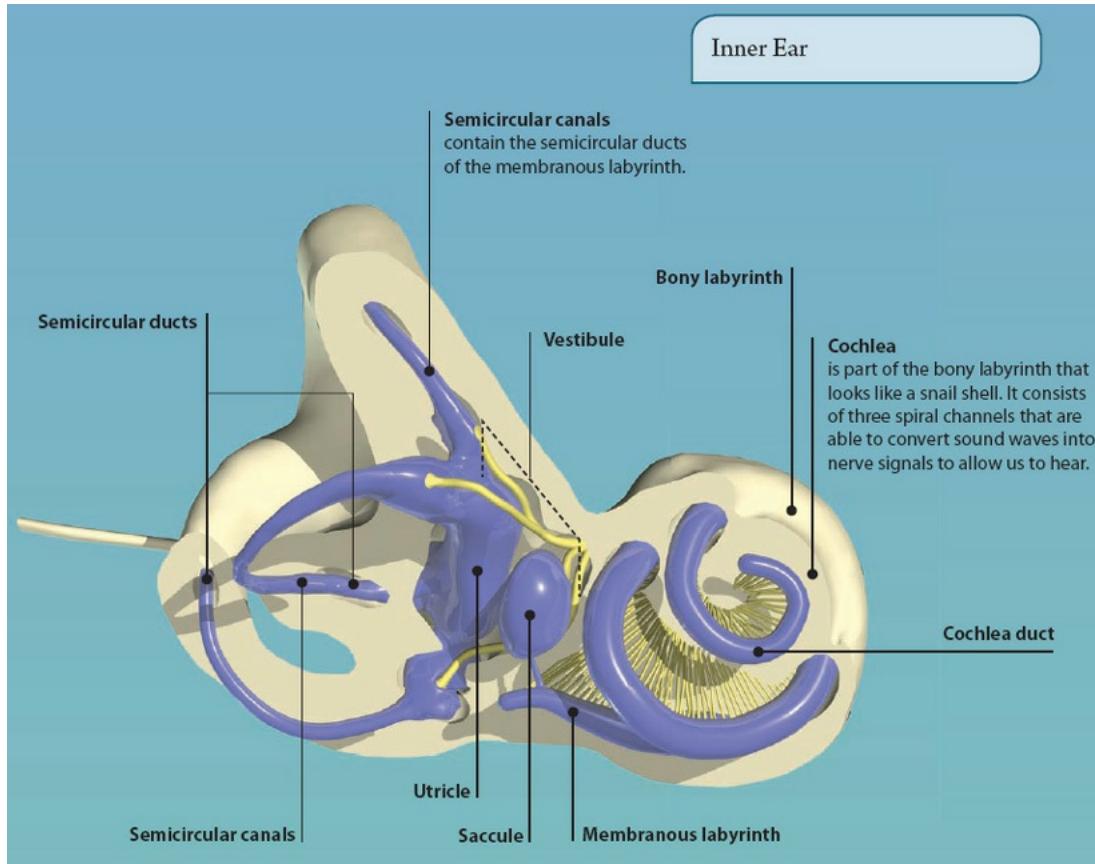
INNER EAR

The inner ear is also known as the labyrinth. It has both bony and membranous parts. The bony labyrinth is found deep within the temporal bone of the skull. It consists of a series of complex, fluid-filled channels that are involved with hearing (cochlea) and balance (vestibule and semicircular canals).

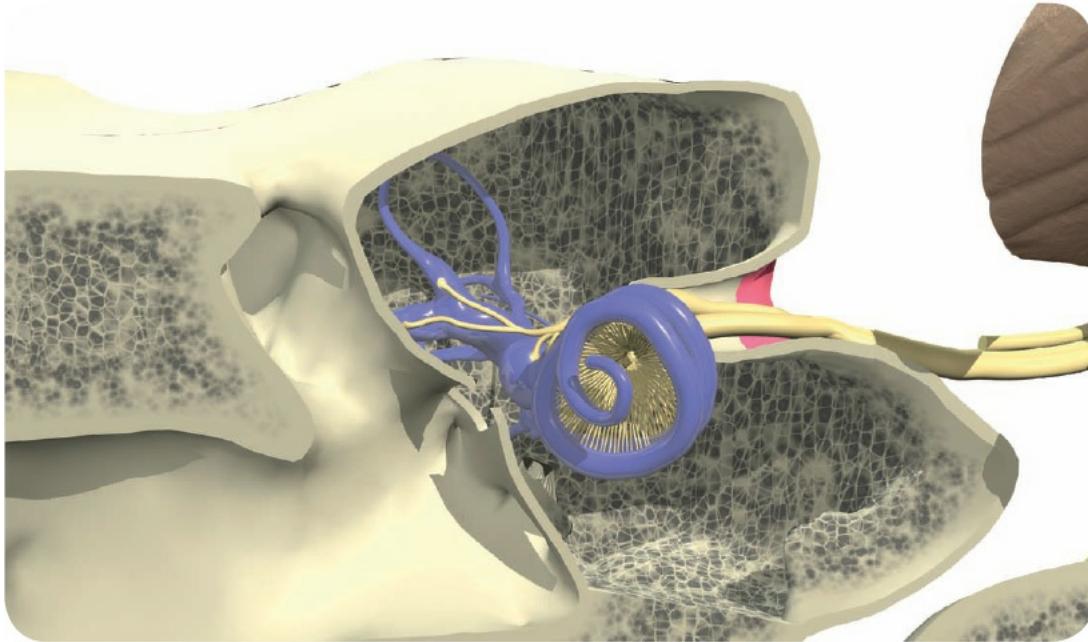
Inside the bony labyrinth is found the membranous labyrinth. It also contains many fluid-filled channels. These often follow the shape of the bony labyrinth, and structures within them contribute to hearing and balance.

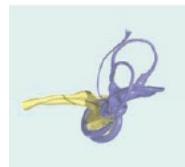
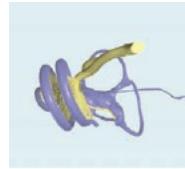
Membranous Labyrinth





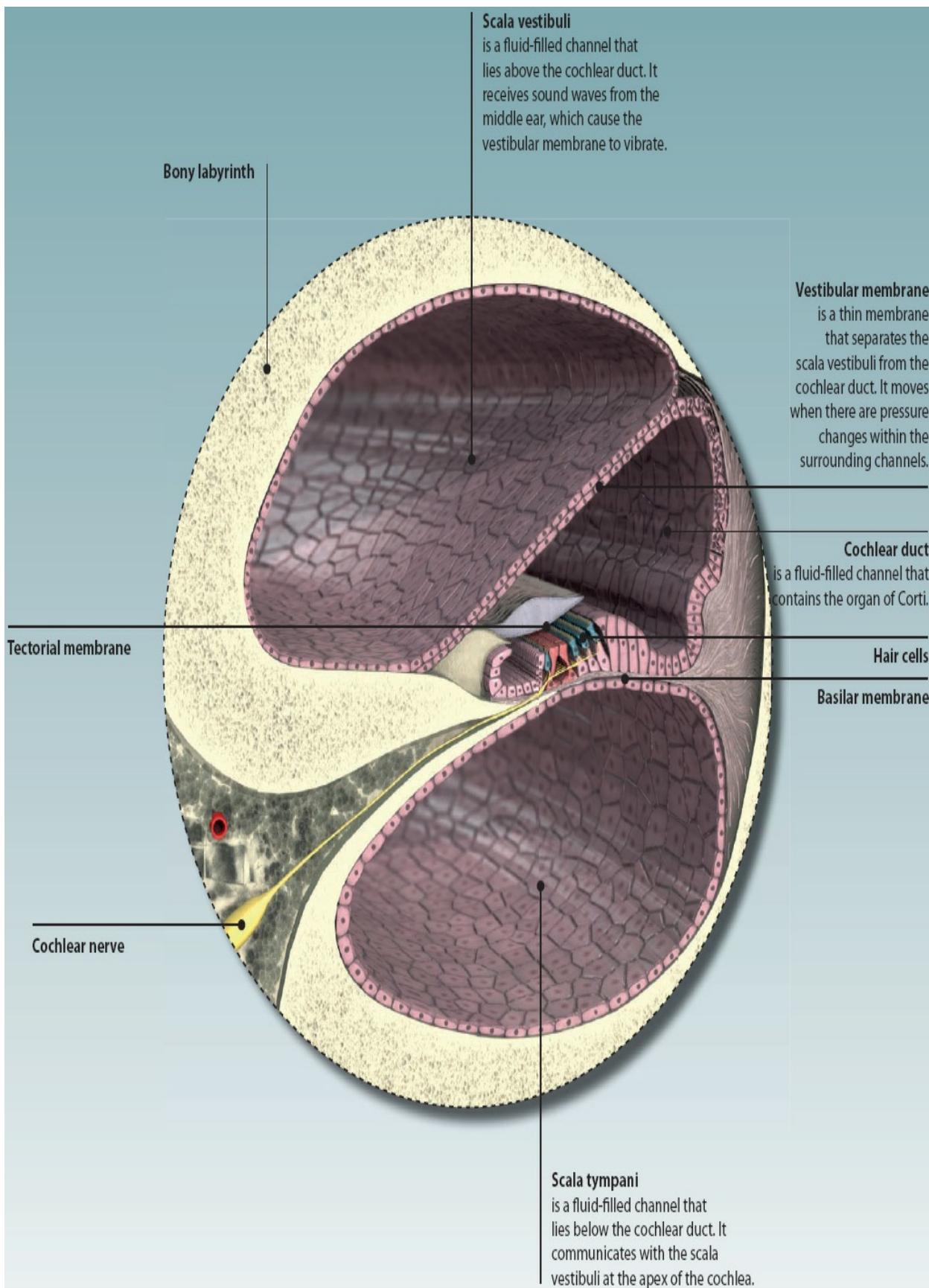
Membranous Labyrinth In-Situ

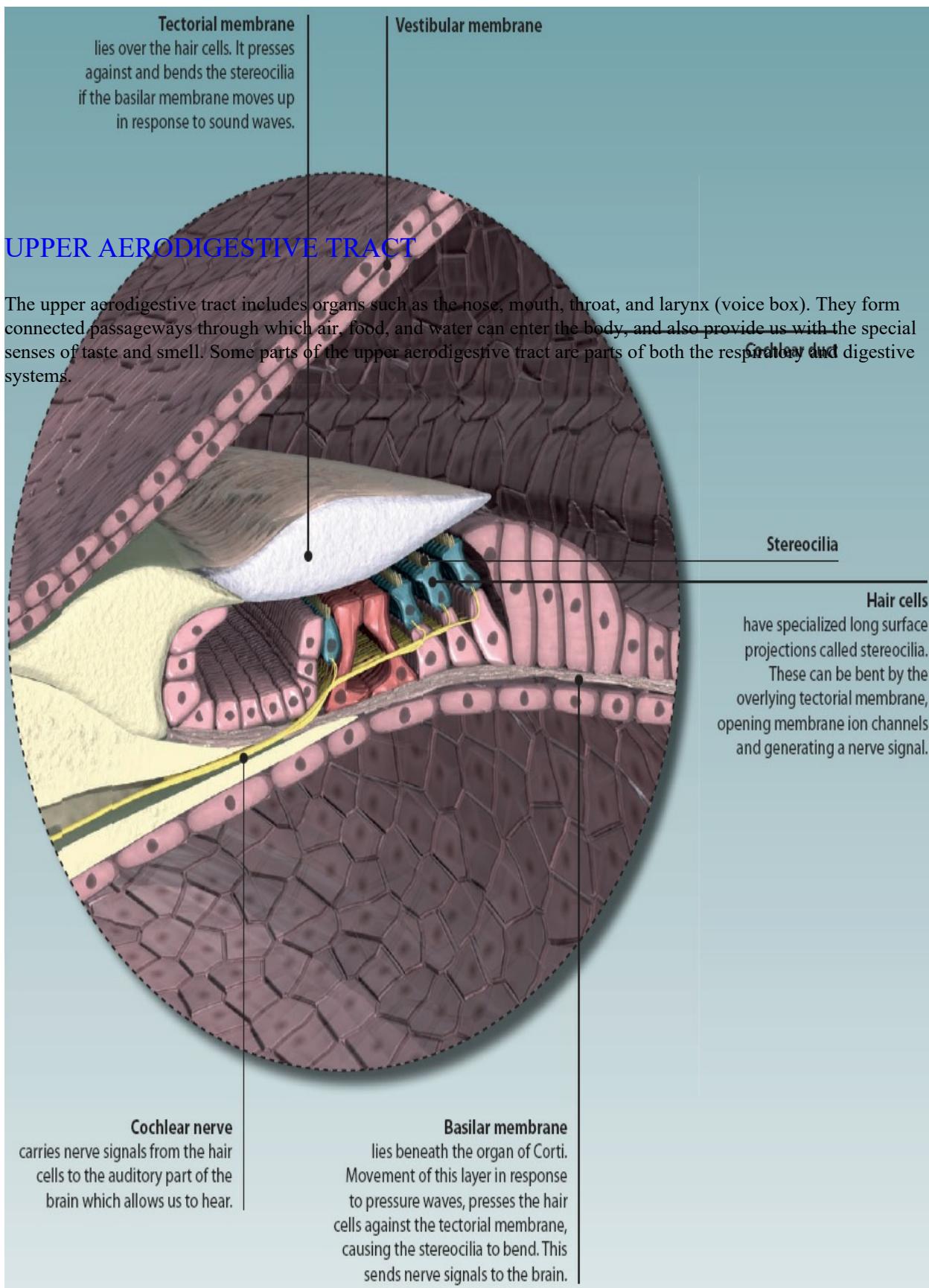


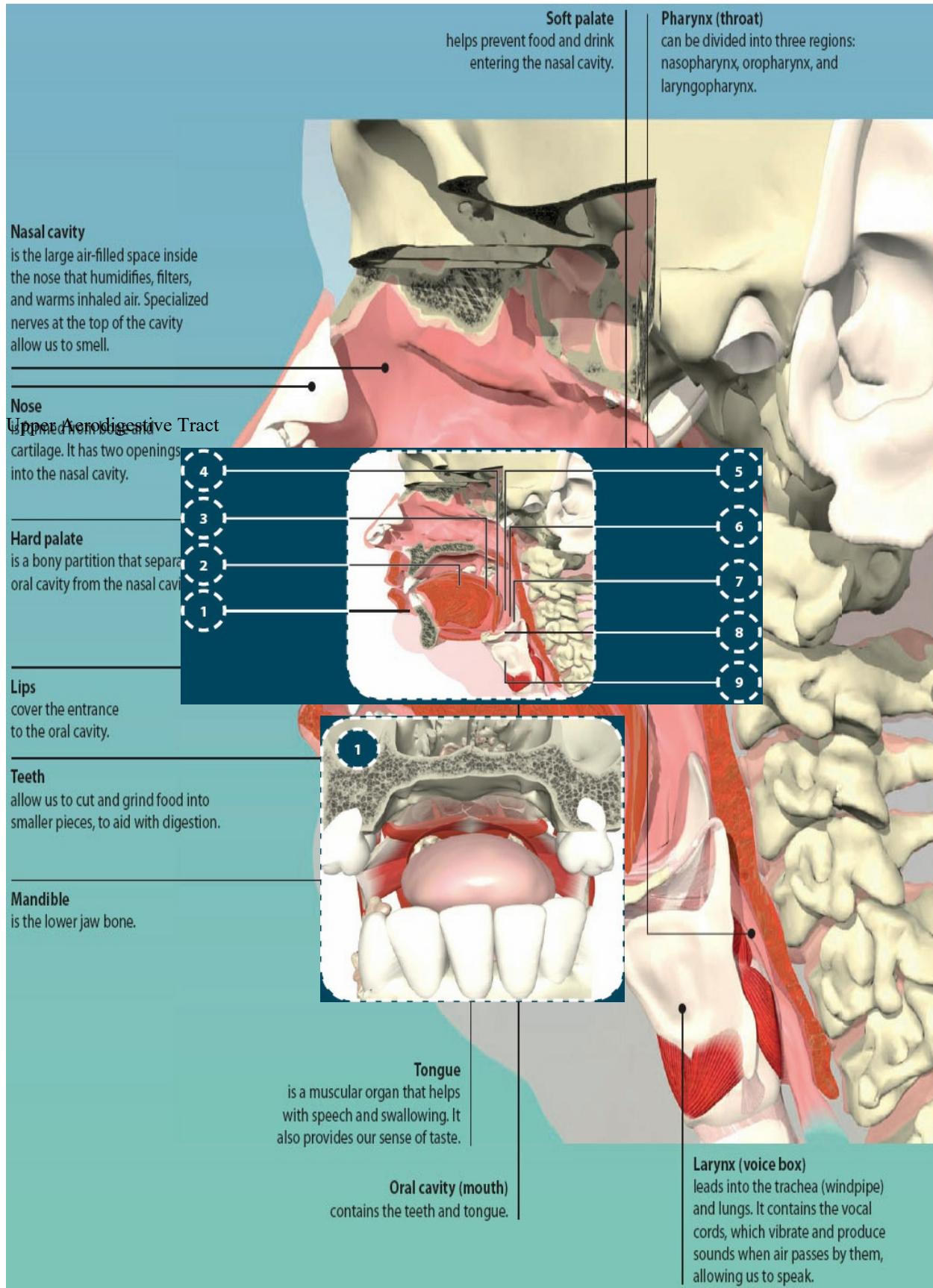


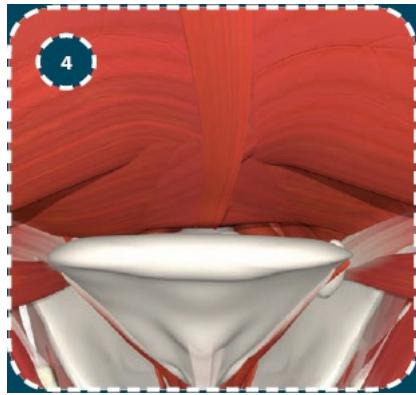
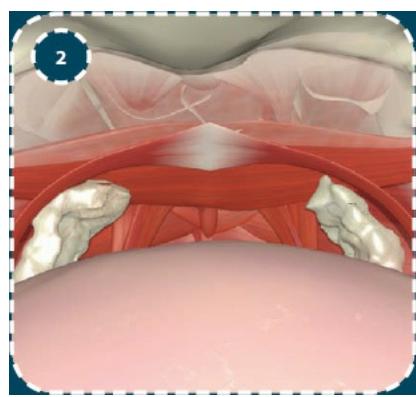
ORGAN OF CORTI

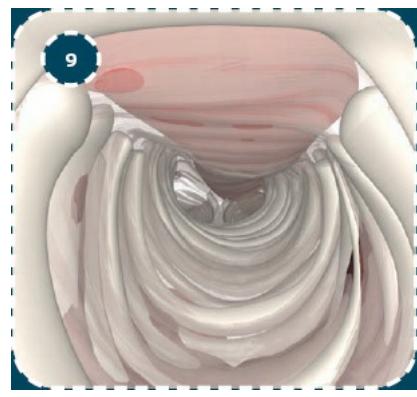
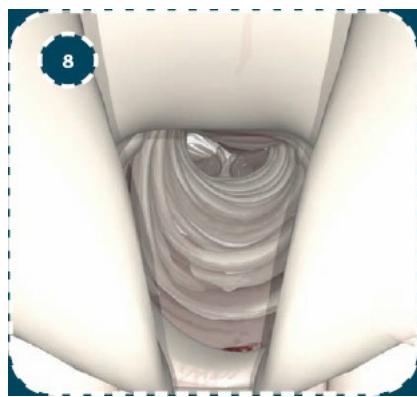
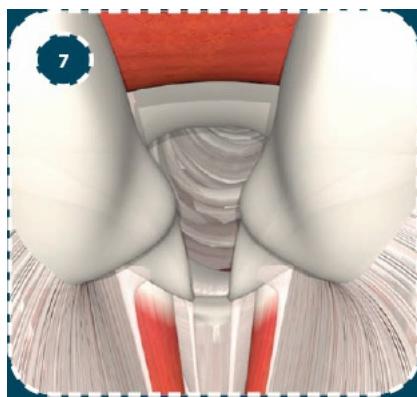
Sound waves transmitted from the middle ear to the inner ear generate pressure waves in three fluid-filled spiral channels in the cochlea. A collection of specialized lining cells and associated structures, called the organ of Corti, detect these pressure changes. They convert them into nerve signals that can be sent to the brain and allow us to hear. The exact region of the cochlea stimulated depends upon the pitch of the sound, and this allows us to interpret different noises.









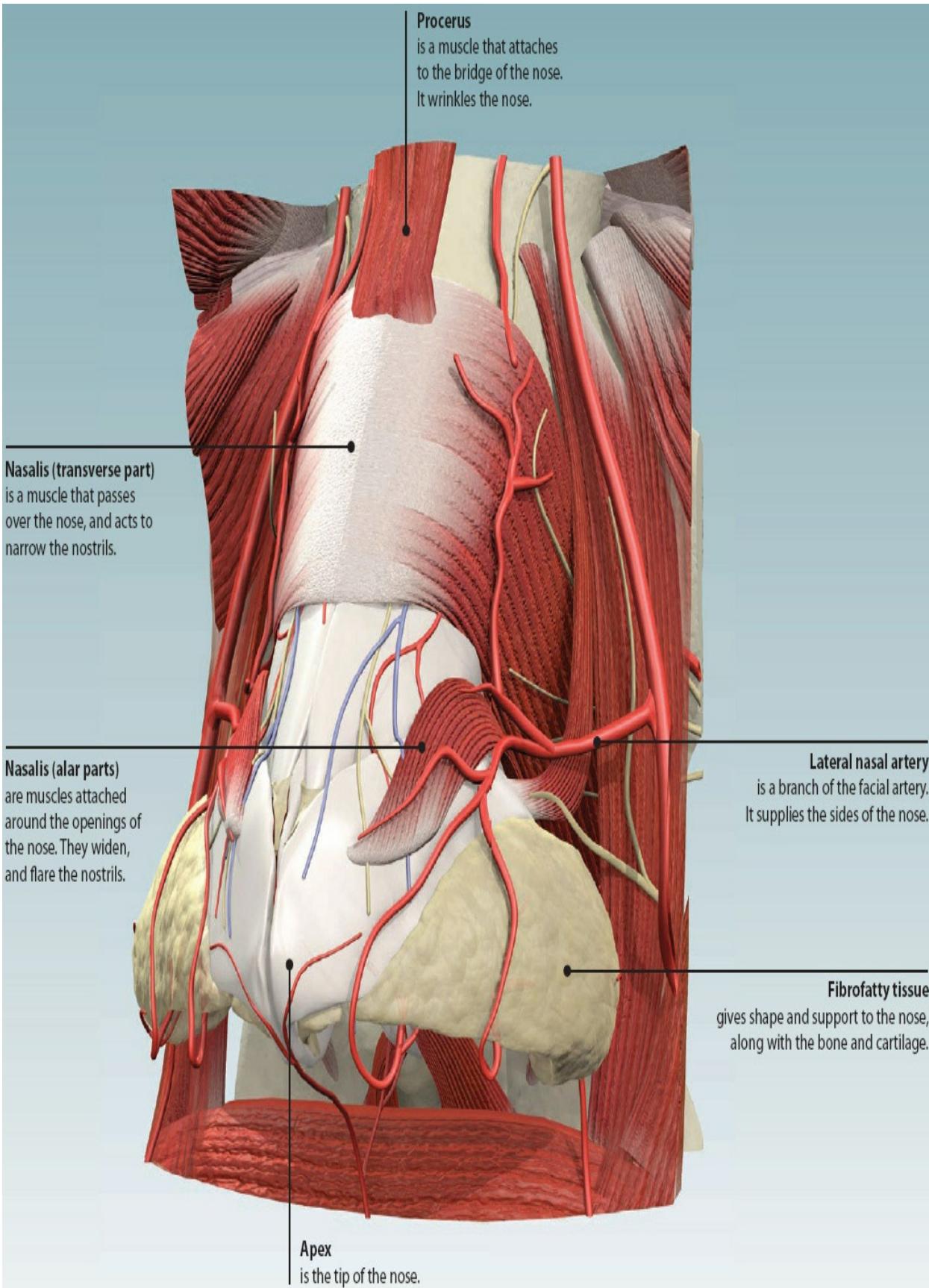


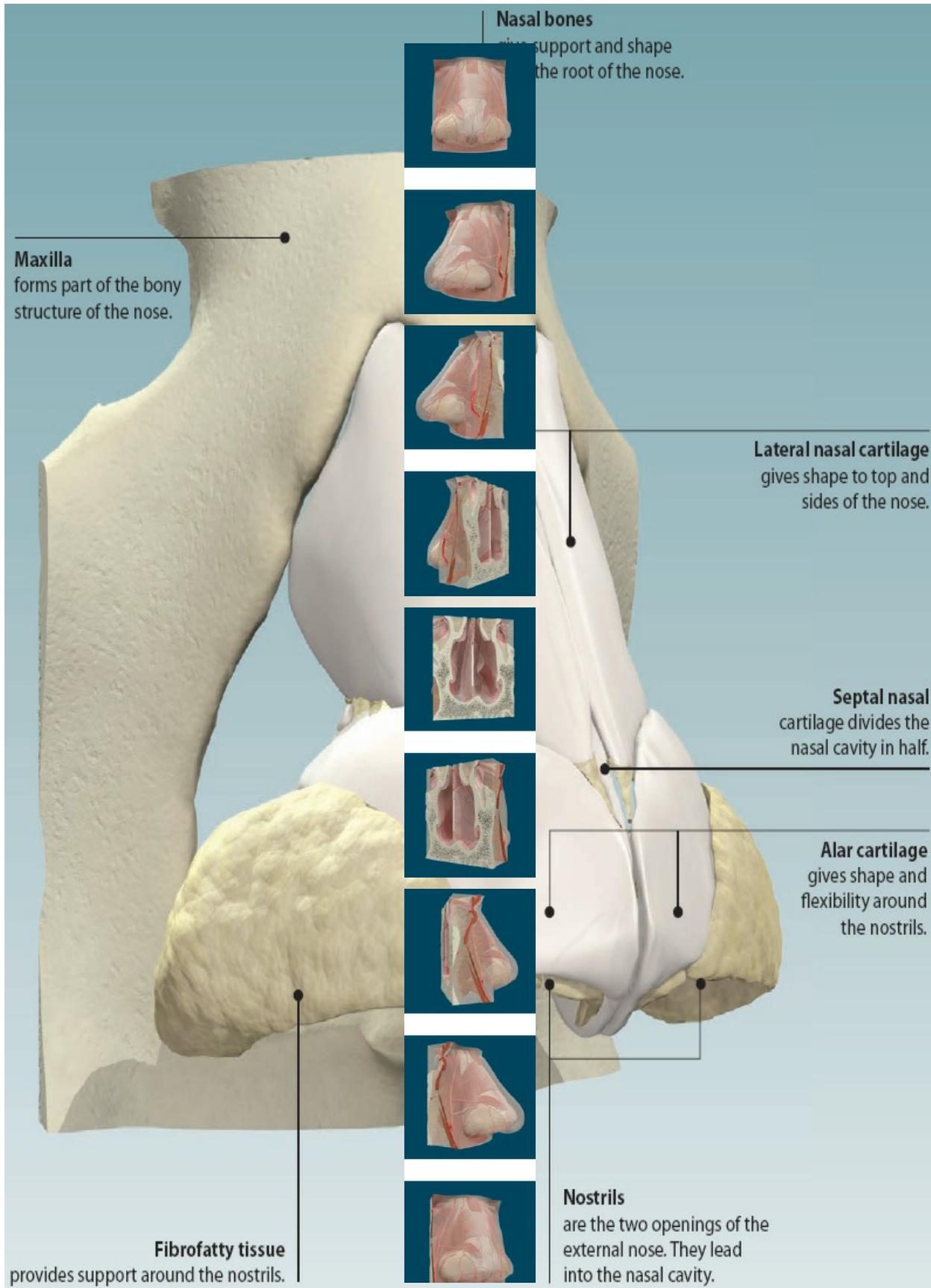
NOSE

The nose is our organ of smell. It forms part of the respiratory system, and has an important role in cleaning and moistening the air we breathe in.

The nose has an outer part and an inner part. The outer part is the visible, pyramid-shaped structure in the middle of our faces. It is made of bone, cartilage, and fibrofatty tissue. There are two openings, directed downwards, on the outer nose. These lead into the inner part of the nose, the nasal cavity, where the specialized smell receptors are found.

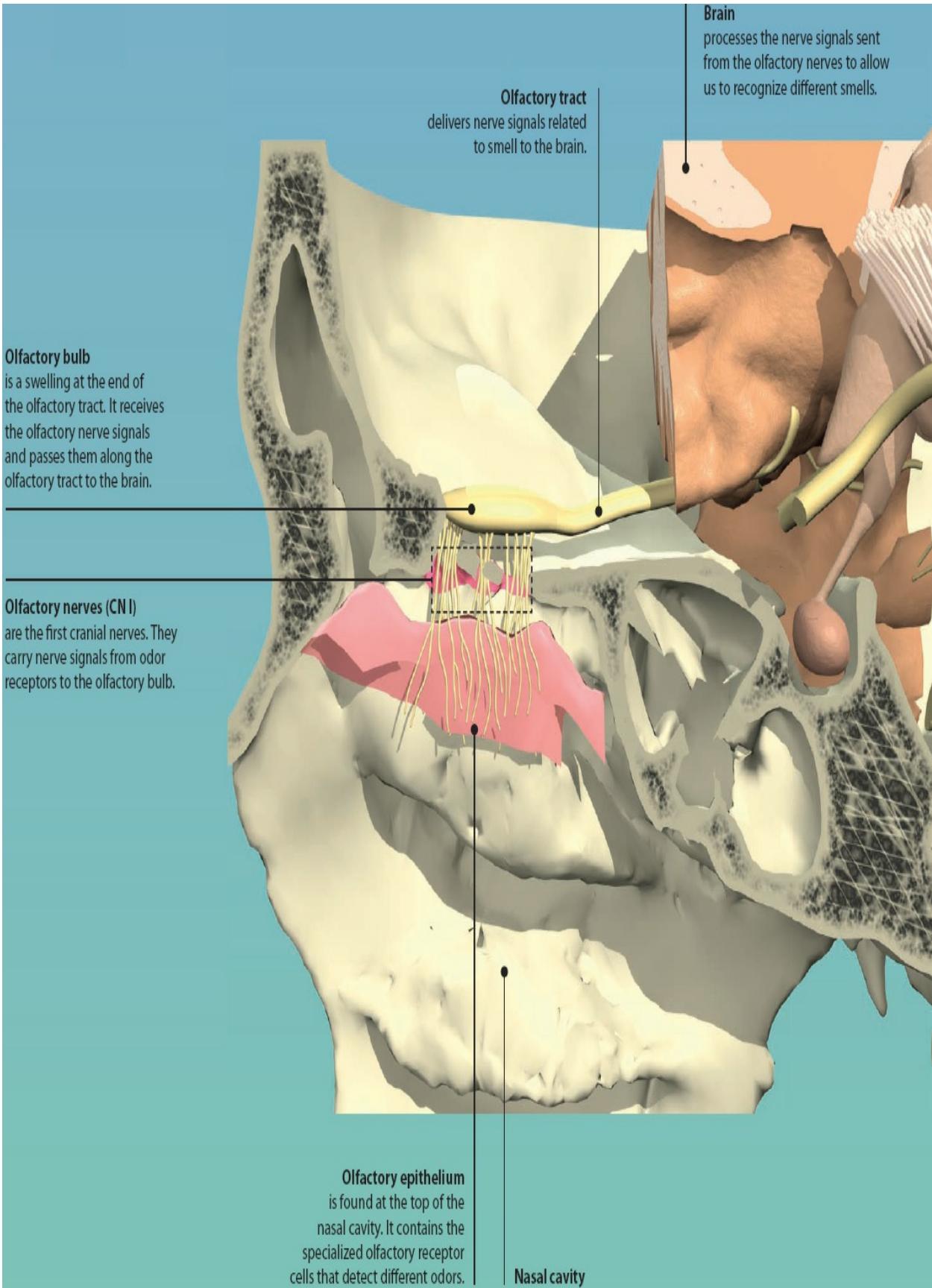
The nose has a rich blood supply, which helps warm and moisten incoming air, but also means that it can bleed easily if it is damaged.

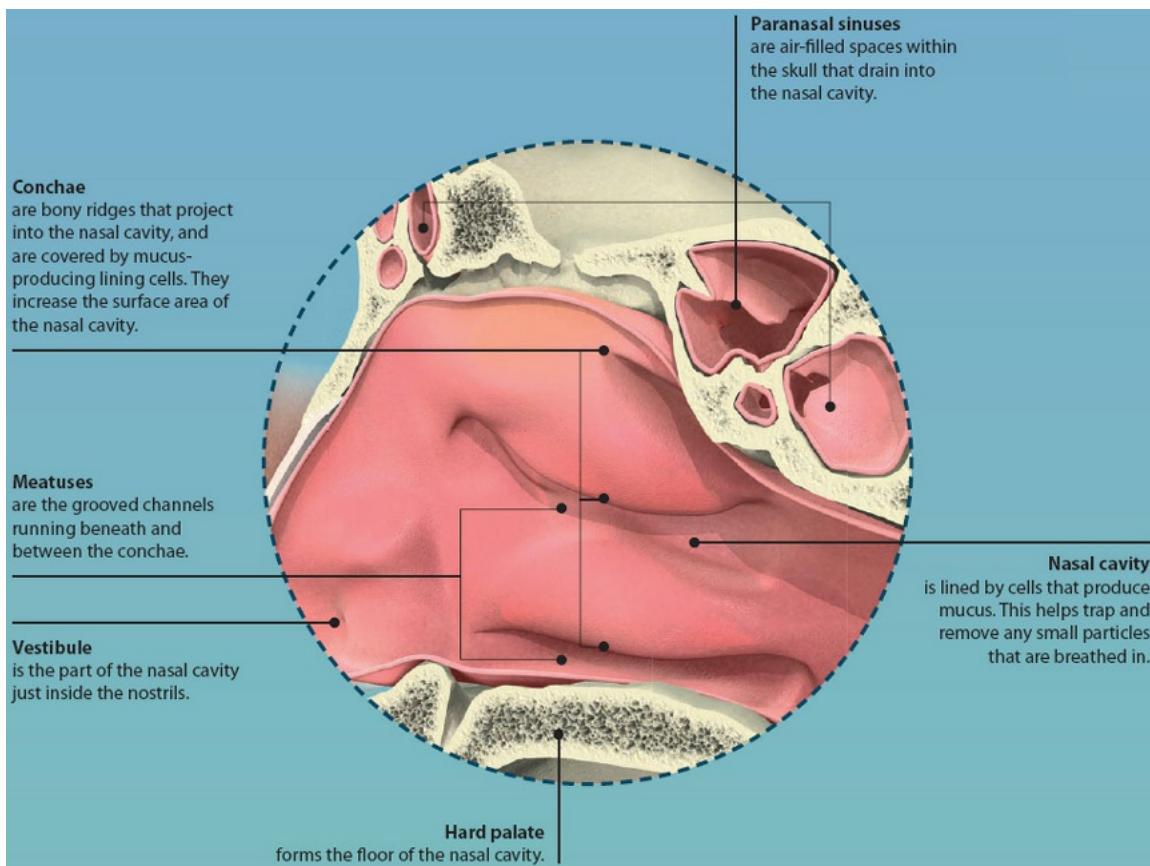
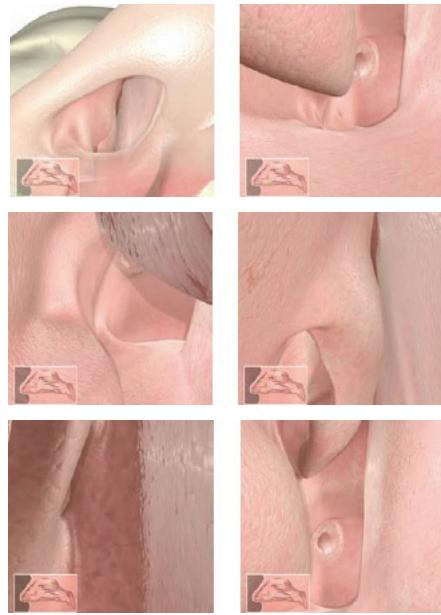




NASAL CAVITY

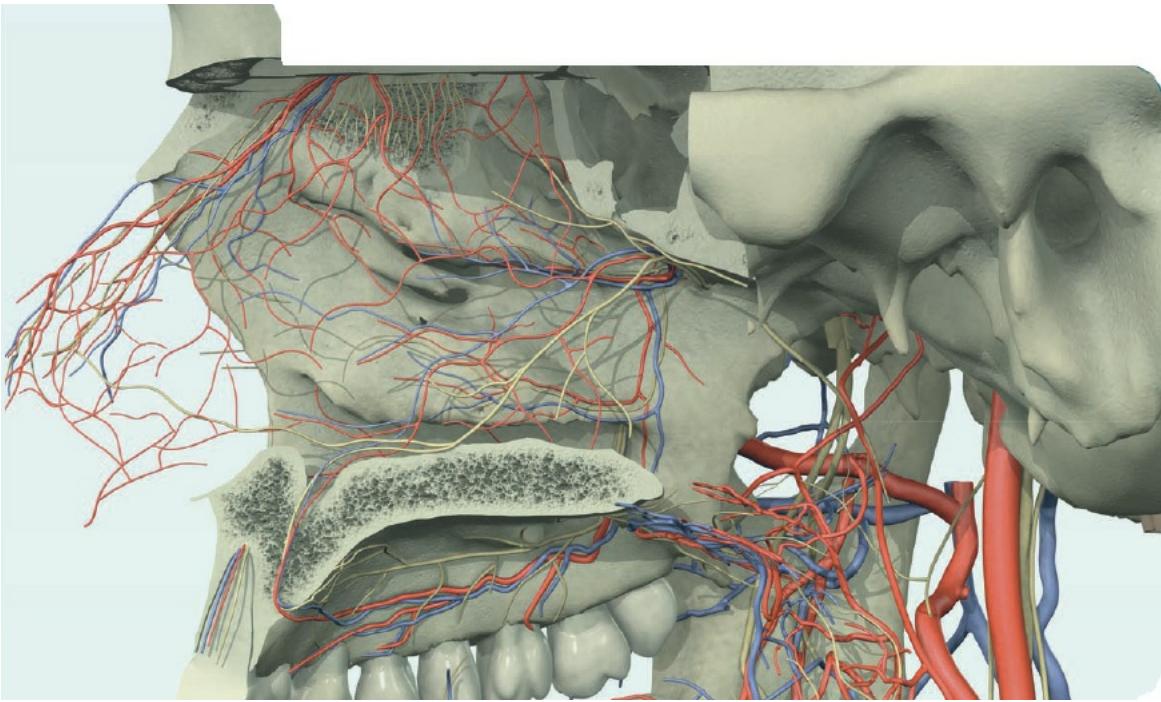
The nasal cavity is the inner part of the nose. It is the space within the skull between the nostrils and the nasopharynx, and is split in half by a vertical bony partition called the septum. The nasal cavity warms, filters, and moistens the air that is breathed in. The nerves that detect smell are found at the top of the nasal cavity.





The Nasal Cavity

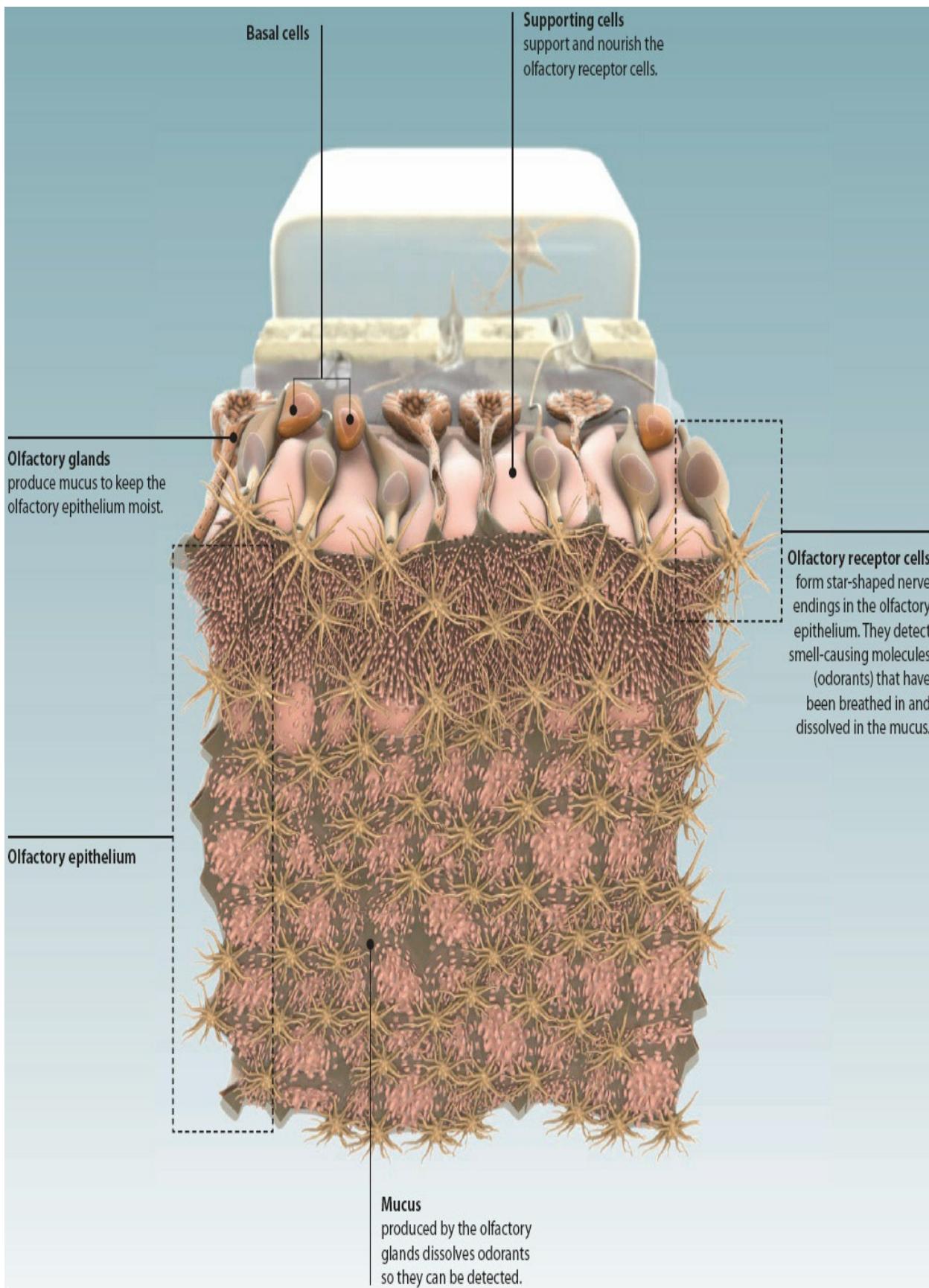
The nasal cavity has a rich blood supply. The numerous blood vessels lie just beneath the lining of the nasal cavity, and allow it to warm and moisten incoming air. They can also be easily damaged, leading to nose bleeds.

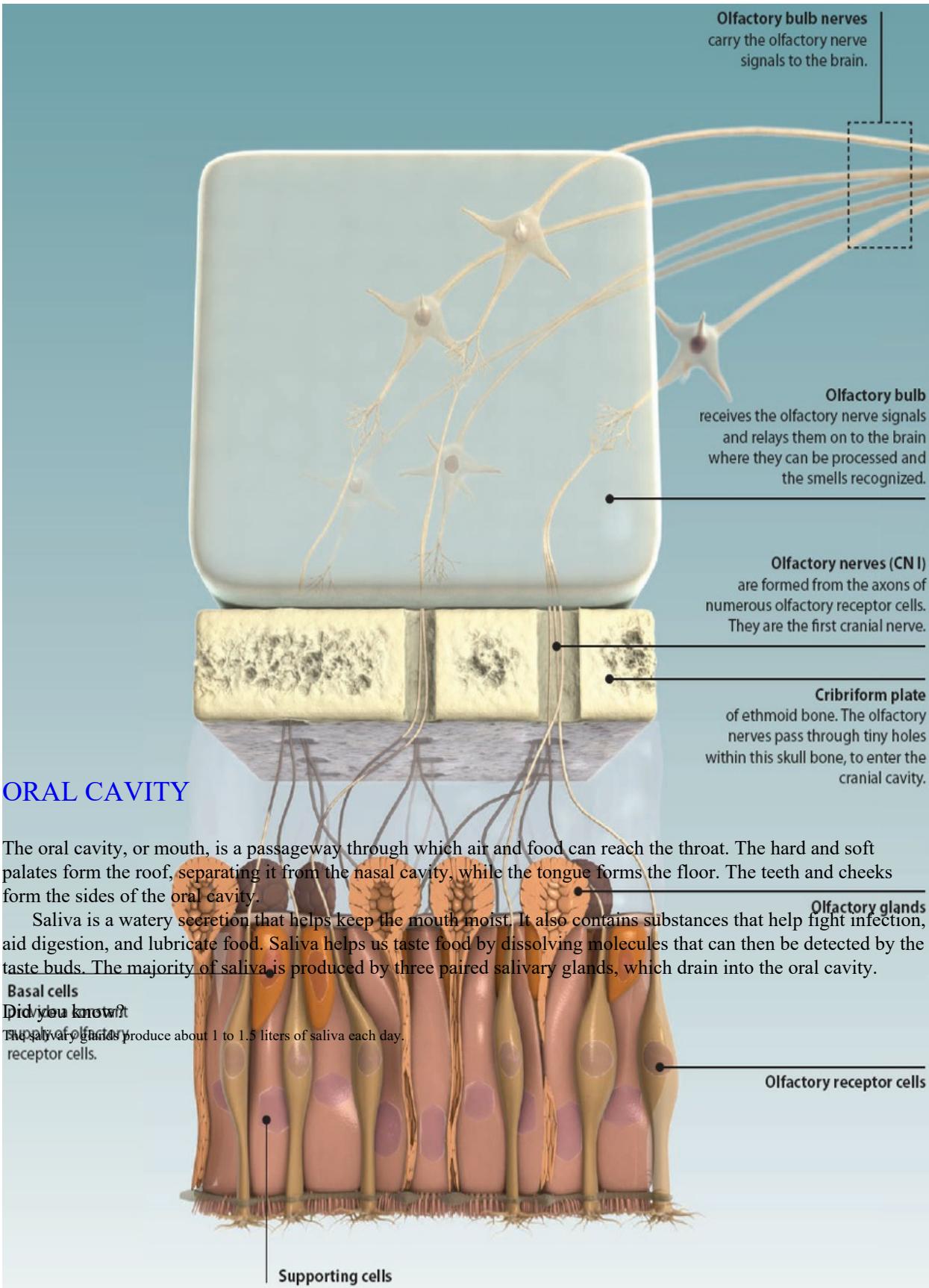


SMELL

Smell, or olfaction, is one of the five special senses. Humans are able to distinguish thousands of different smells.

The olfactory epithelium at the top of the nasal cavity contains millions of olfactory receptor cells. These specialized nerve cells detect different odor causing molecules (odorants) that have been breathed in and dissolved in the mucus coating the olfactory epithelium. These odorants generate a nerve signal that is passed to the brain for processing and the recognition of a distinct smell.





ORAL CAVITY

The oral cavity, or mouth, is a passageway through which air and food can reach the throat. The hard and soft palates form the roof, separating it from the nasal cavity, while the tongue forms the floor. The teeth and cheeks form the sides of the oral cavity.

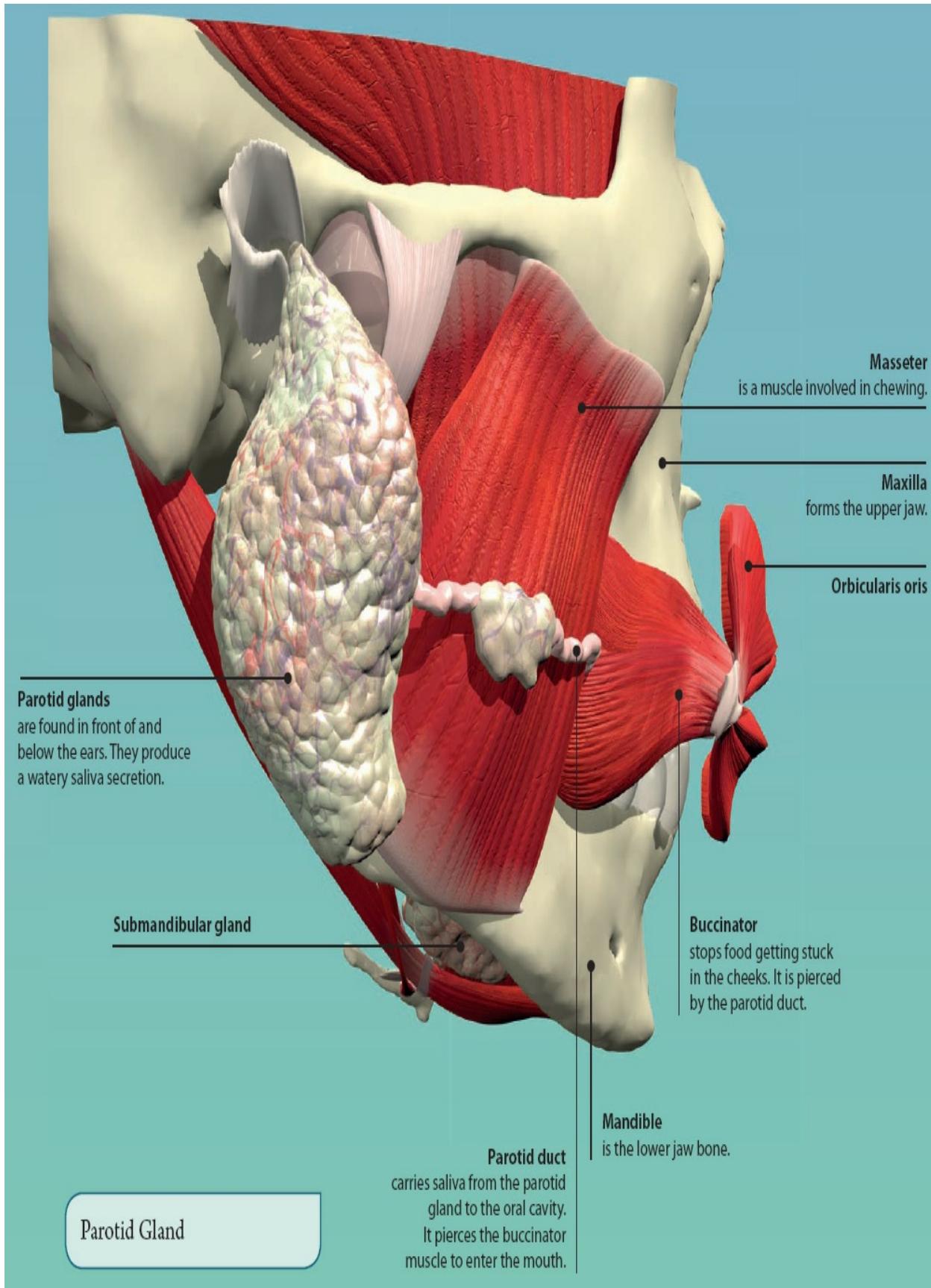
Saliva is a watery secretion that helps keep the mouth moist. It also contains substances that help fight infection, aid digestion, and lubricate food. Saliva helps us taste food by dissolving molecules that can then be detected by the taste buds. The majority of saliva is produced by three paired salivary glands, which drain into the oral cavity.

Basal cells

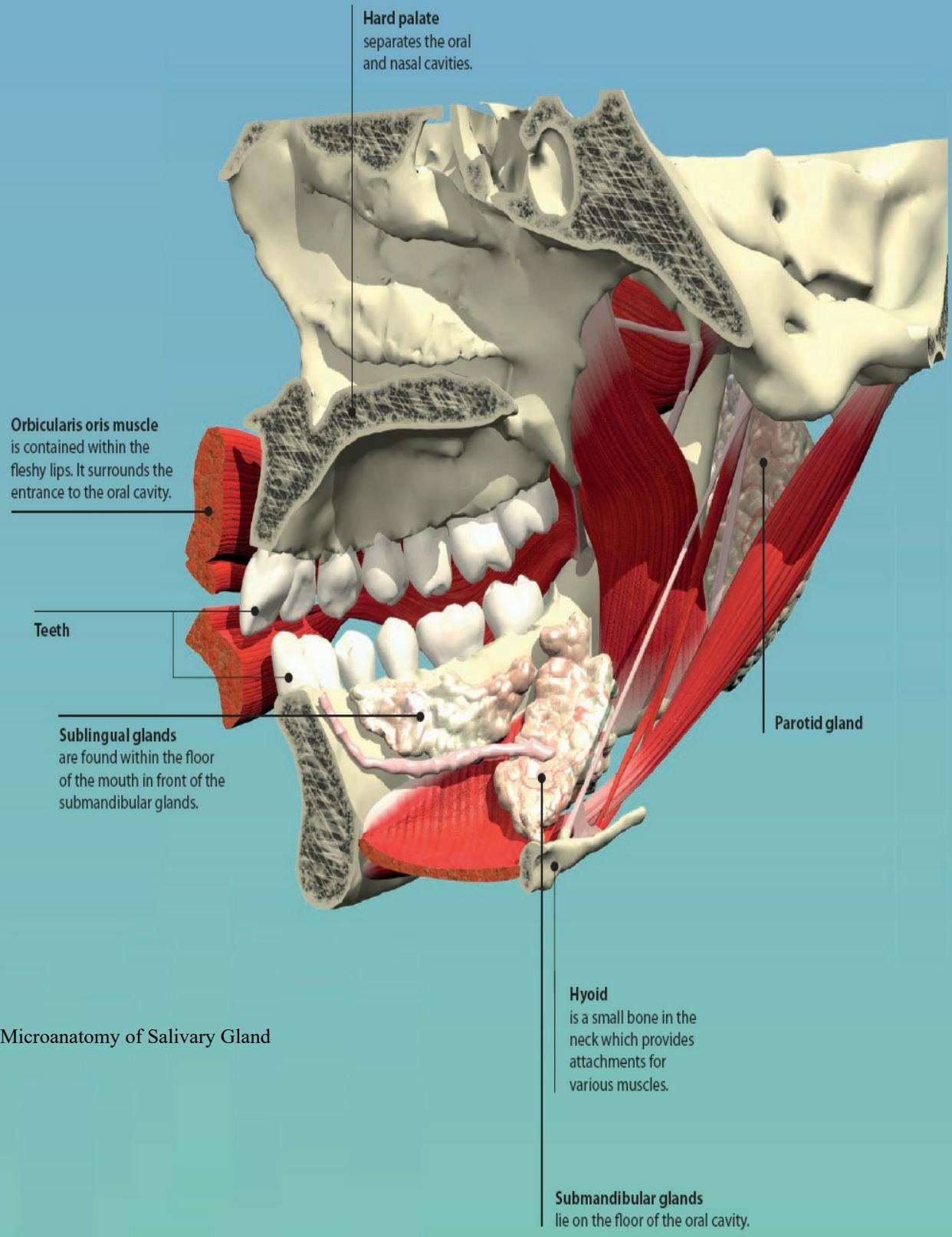
Did you know?

The salivary glands produce about 1 to 1.5 liters of saliva each day.

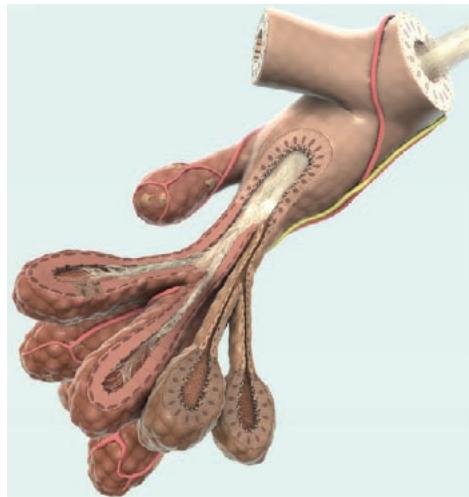
Supporting cells



Submandibular and Sublingual Glands



Microanatomy of Salivary Gland

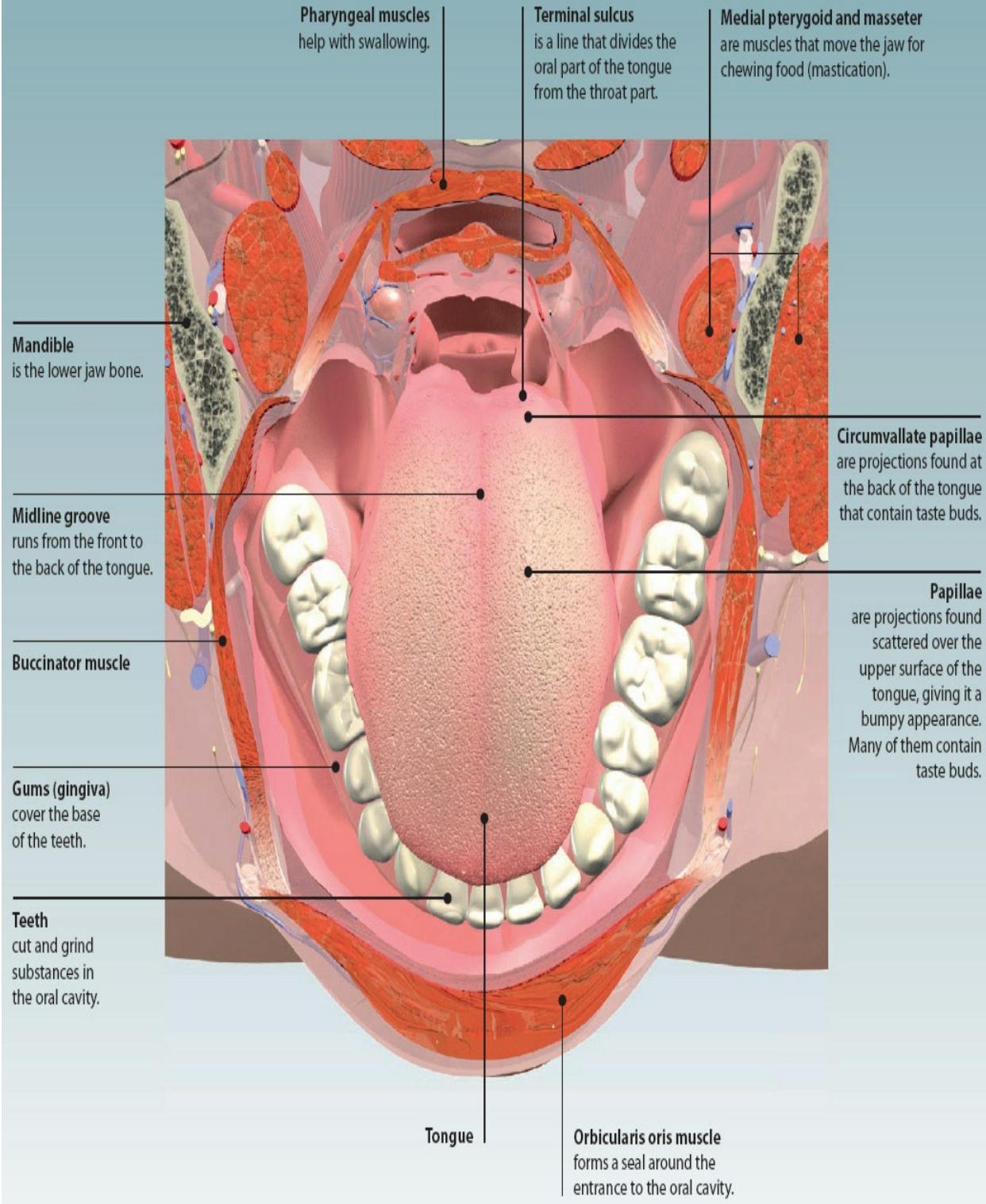


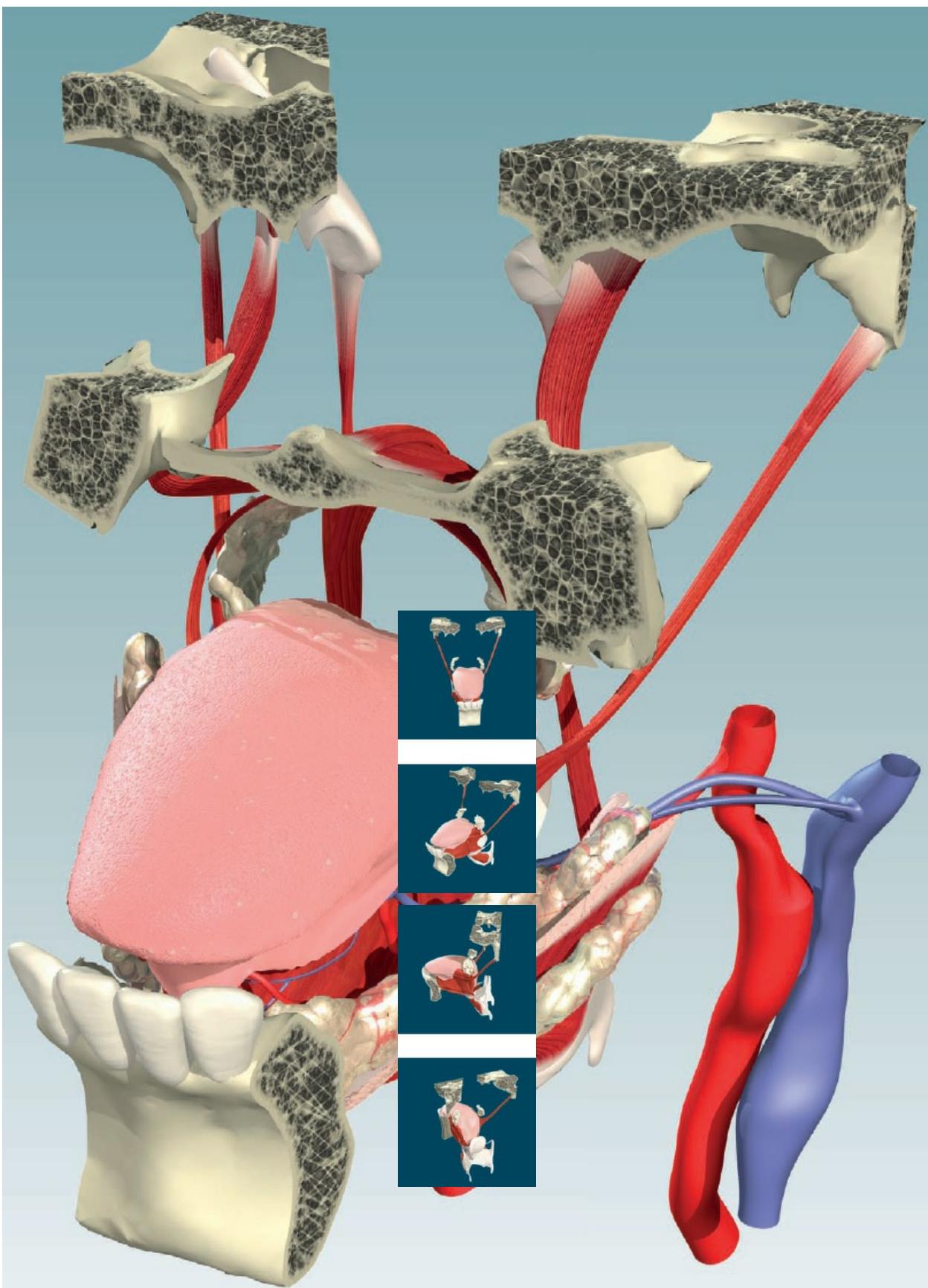
TONGUE

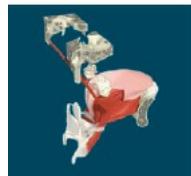
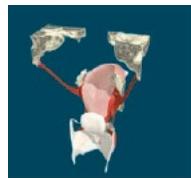
The tongue forms the floor of the oral cavity (mouth), and also extends into part of the pharynx (throat). It is a strong muscular organ, with a roughened top surface and smooth underside. Its top surface has numerous taste buds that allow us to distinguish sweet, salt, sour, bitter, and savory (umami) tastes.

The muscles of the tongue are used to shape and mould food, assist with swallowing, as well as allowing for the delicate, intricate movements required to form words for speech.

Tongue from Above



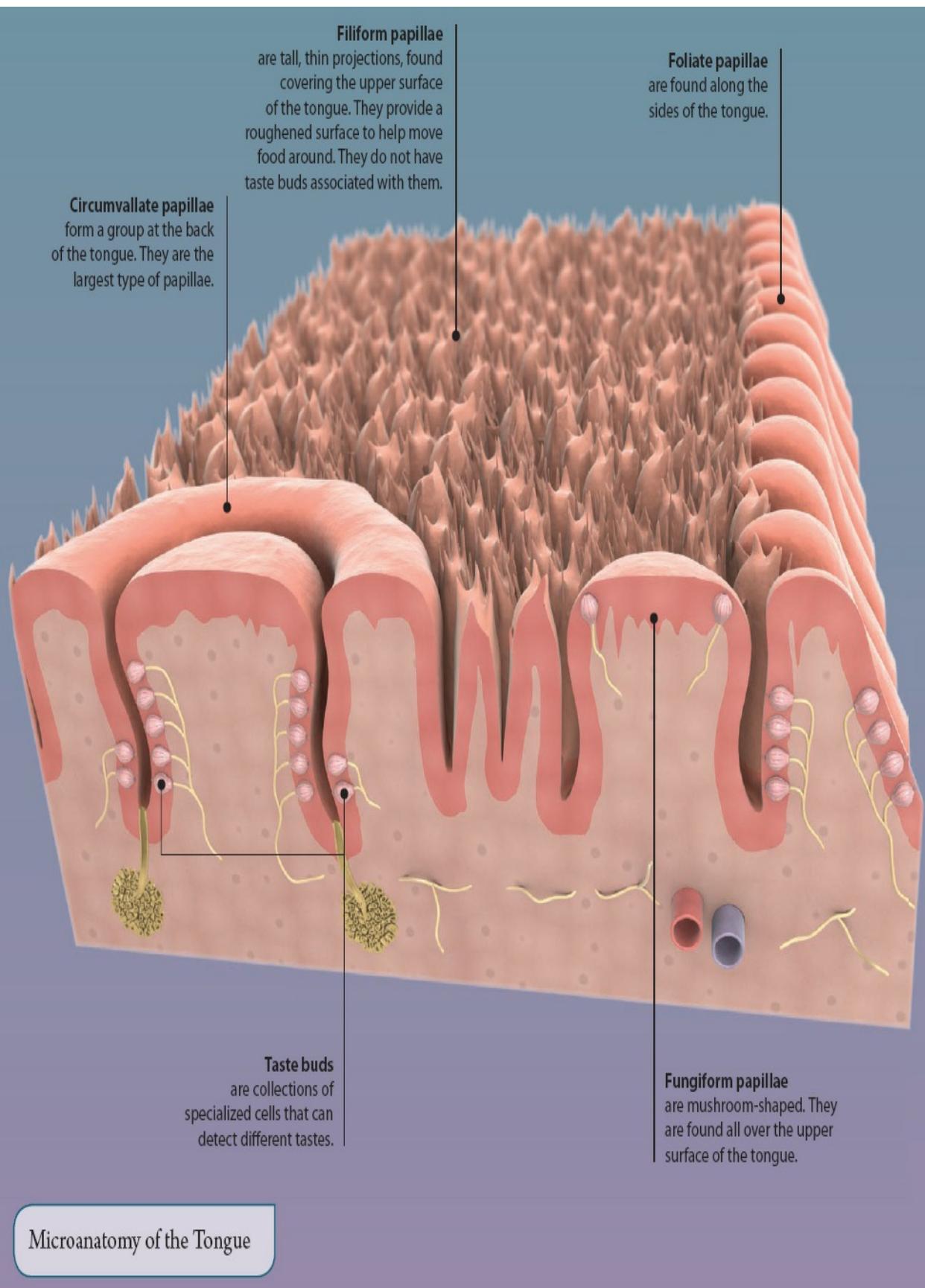




TASTE BUDS

Taste buds are pear-shaped collections of specialized cells, which are able to detect small molecules of food dissolved in the saliva. These molecules trigger a nerve signal to be sent to the brain, which is interpreted as the sensation of taste (gustation). The five main taste types are sweet, salty, savory (umami), bitter, and sour. Taste sensation is carried to the brain in cranial nerves VII (facial) and IX (glossopharyngeal).

We have approximately 10,000 taste buds. Most of these are found on the upper surface of the tongue, related to projections of the tongue surface, called papillae. These give the upper surface of the tongue its roughened appearance.

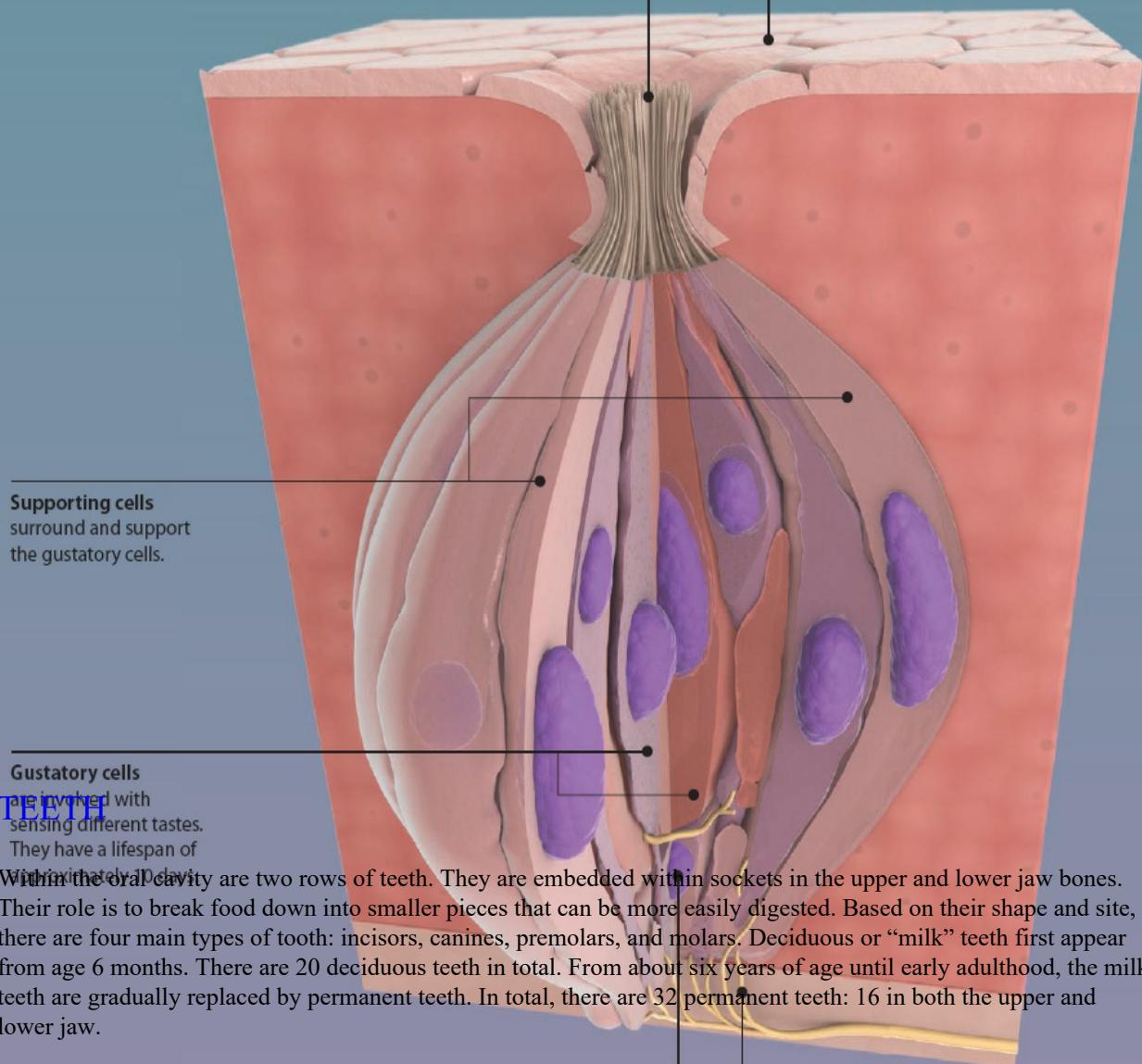


Microanatomy of the Tongue

Taste Bud

Taste pore is a small opening onto the tongue surface. It allows the contents of the oral cavity to access the taste buds.

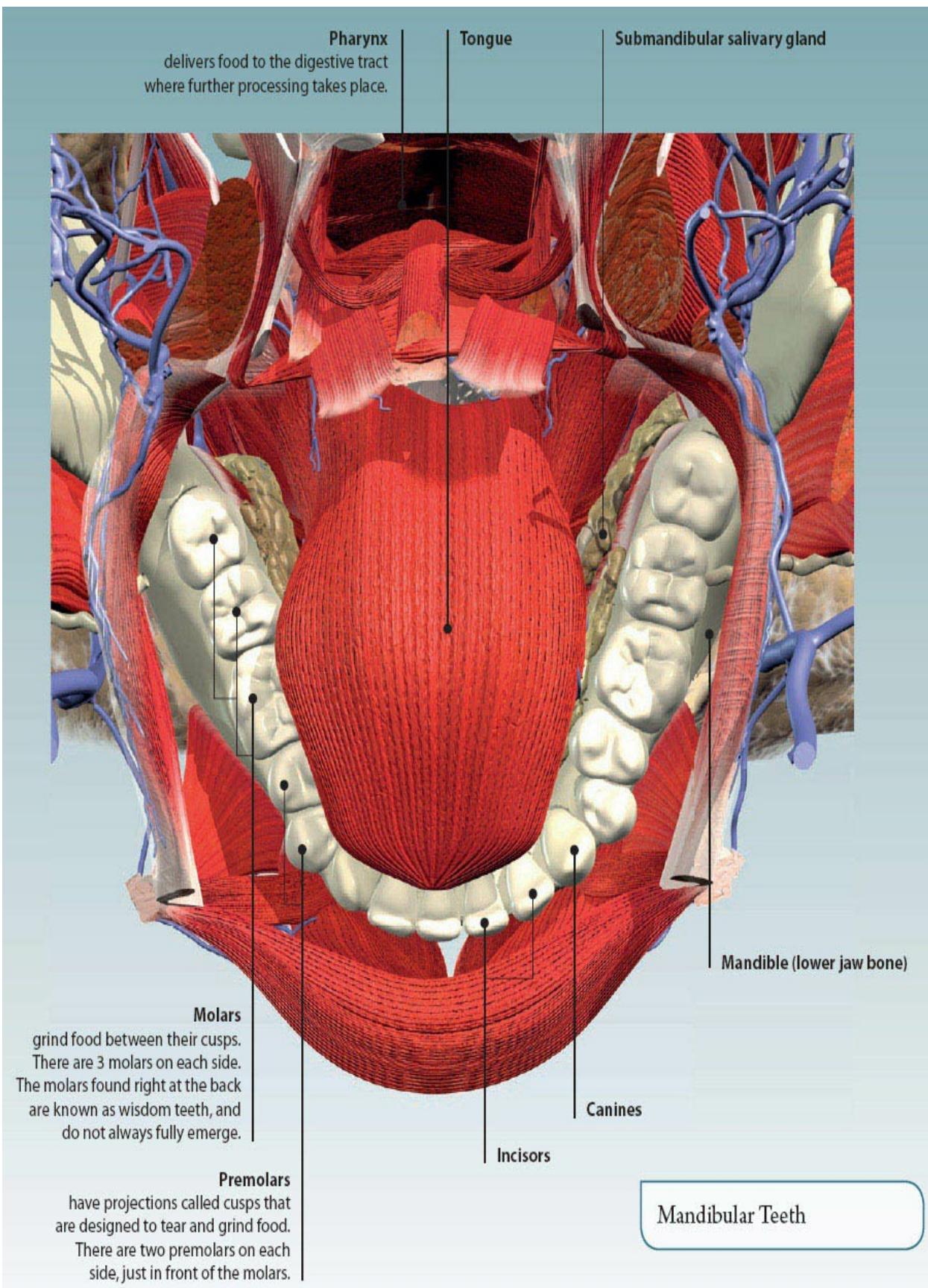
Tongue surface



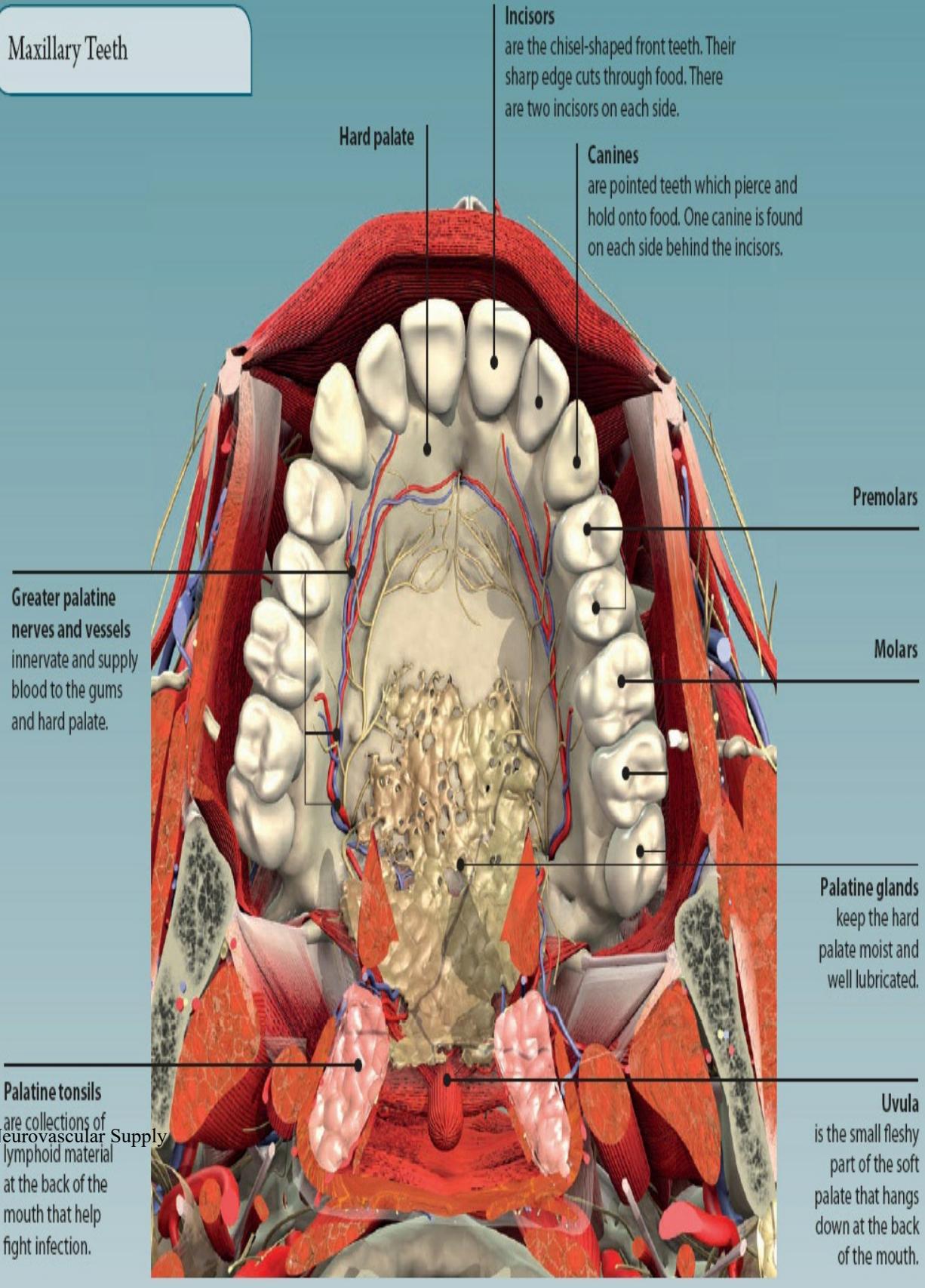
TEETH
Within the oral cavity are two rows of teeth. They are embedded within sockets in the upper and lower jaw bones. Their role is to break food down into smaller pieces that can be more easily digested. Based on their shape and site, there are four main types of tooth: incisors, canines, premolars, and molars. Deciduous or "milk" teeth first appear from age 6 months. There are 20 deciduous teeth in total. From about six years of age until early adulthood, the milk teeth are gradually replaced by permanent teeth. In total, there are 32 permanent teeth: 16 in both the upper and lower jaw.

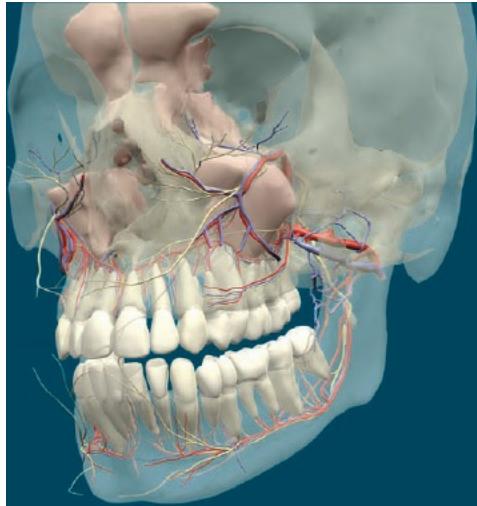
Basal cells are small cells found at the bottom of the taste bud. They provide a constant supply of gustatory and supporting cells.

Nerve fibers carry the taste signals to the brain.

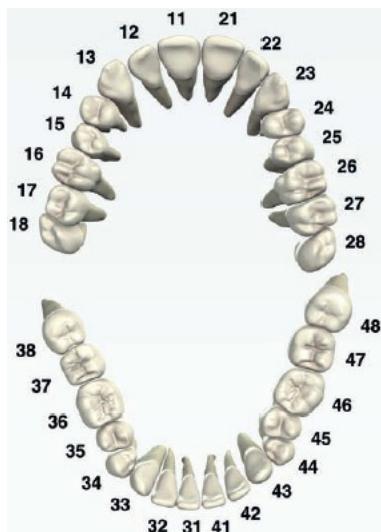


Maxillary Teeth





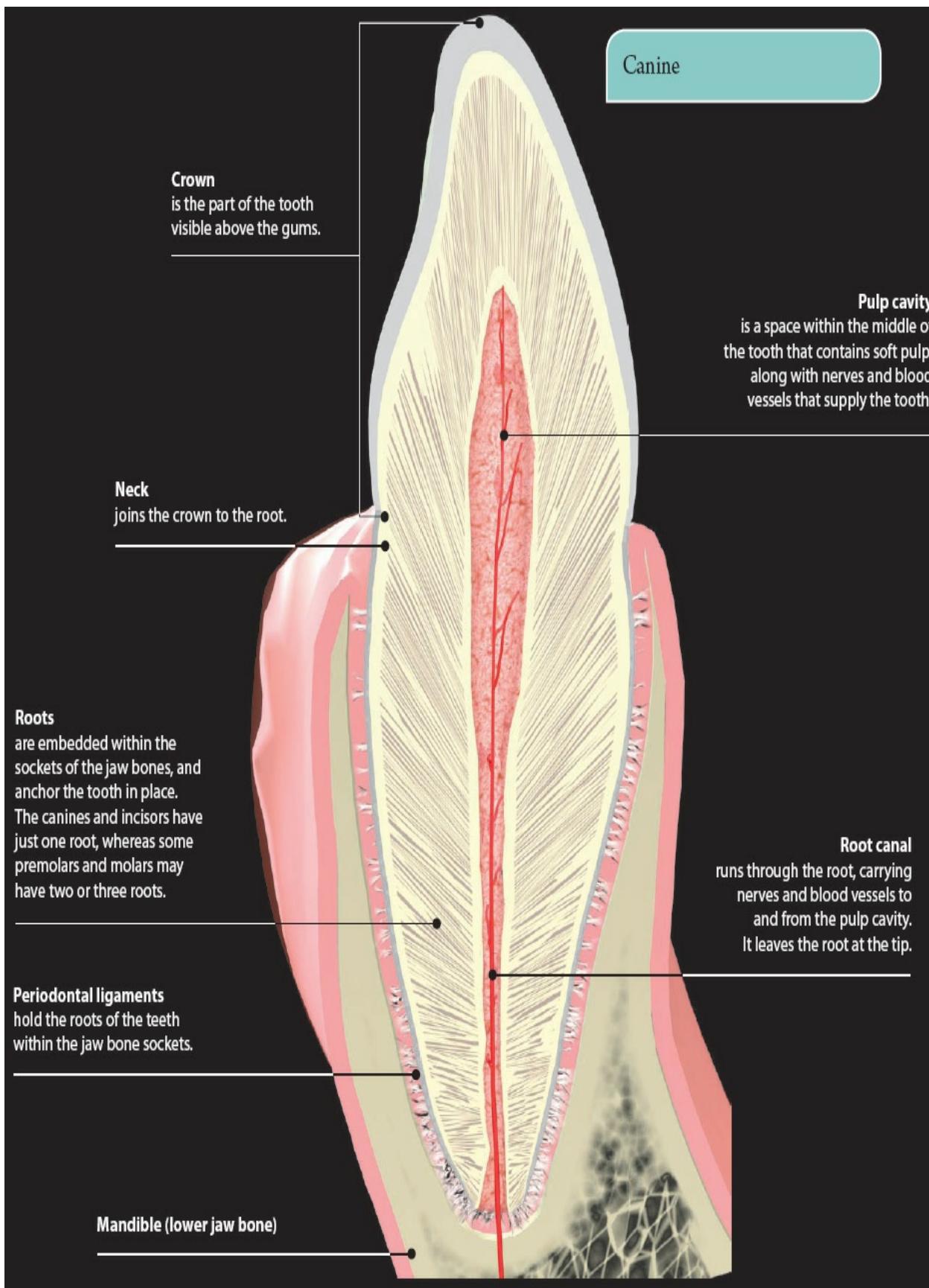
FDI World Dental Federation Notation

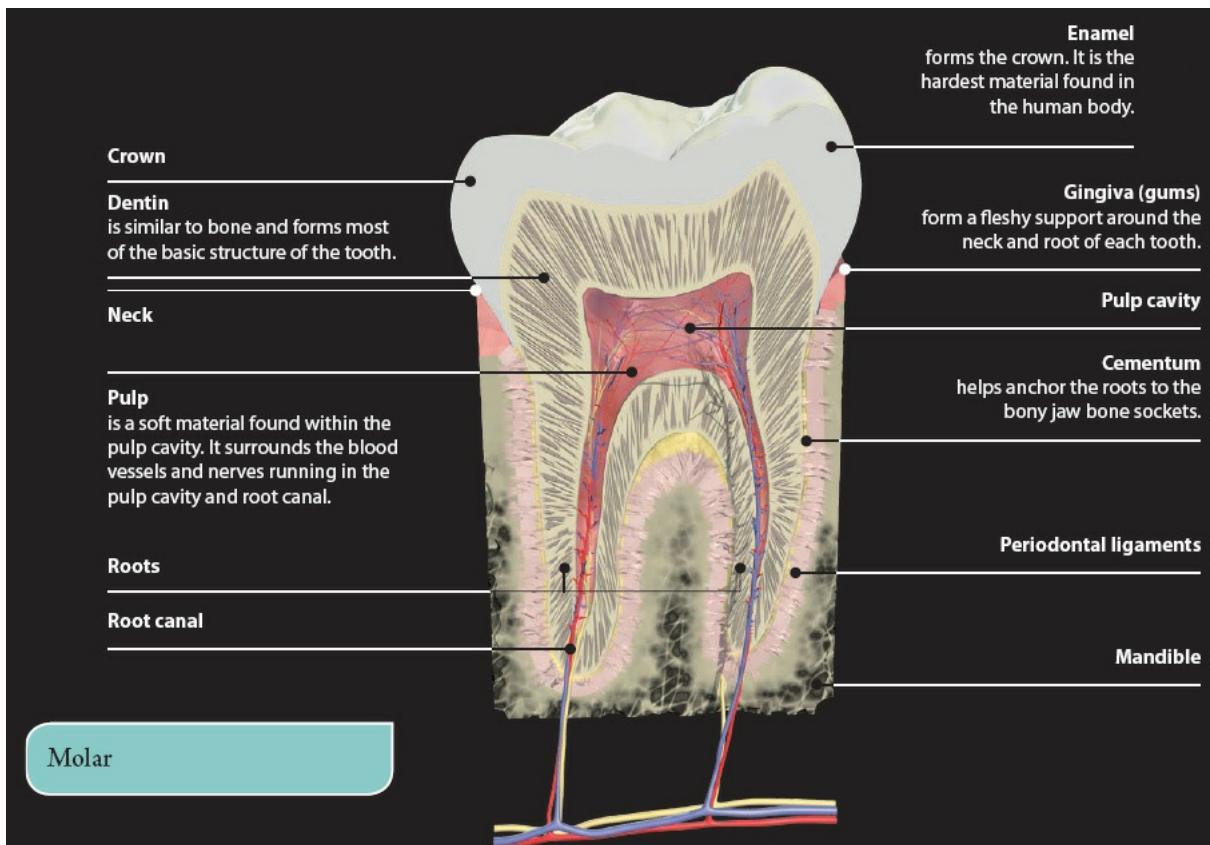


THE TOOTH

Although there are different shapes and types of teeth, they all have the same basic structure and are made of the same materials. They all have a crown, neck, root, and pulp cavity and are all made from enamel, dentin, cementum, and pulp.

The structure of teeth can be damaged by exposure to bacteria and sugars. These can break down the tough outer enamel layer leading to cavities, and possibly painful dental abscesses. Prompt treatment is needed to drain the infection and seal the holes with a filling.





Disease



Abscess



Cavities



Gingivitis and periodontal disease



Pulp penetrating decay



Pulpitis

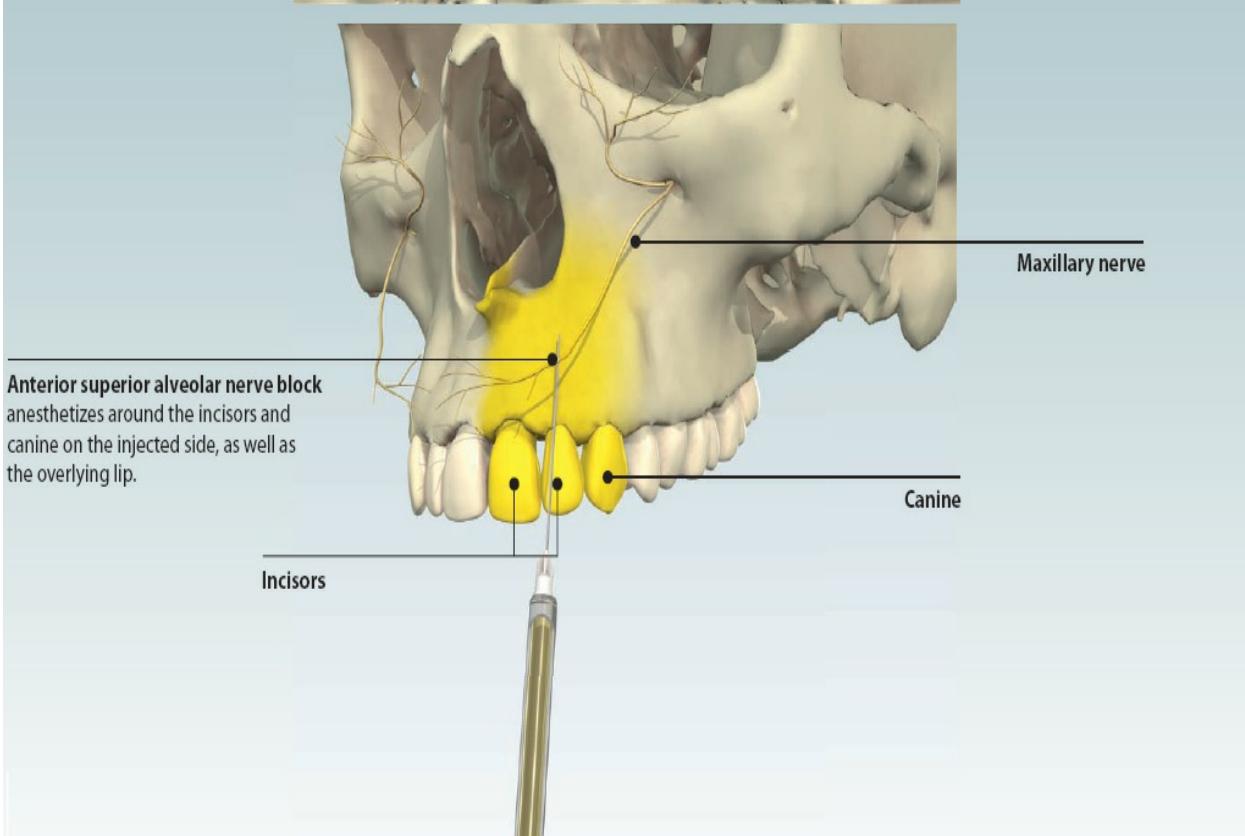
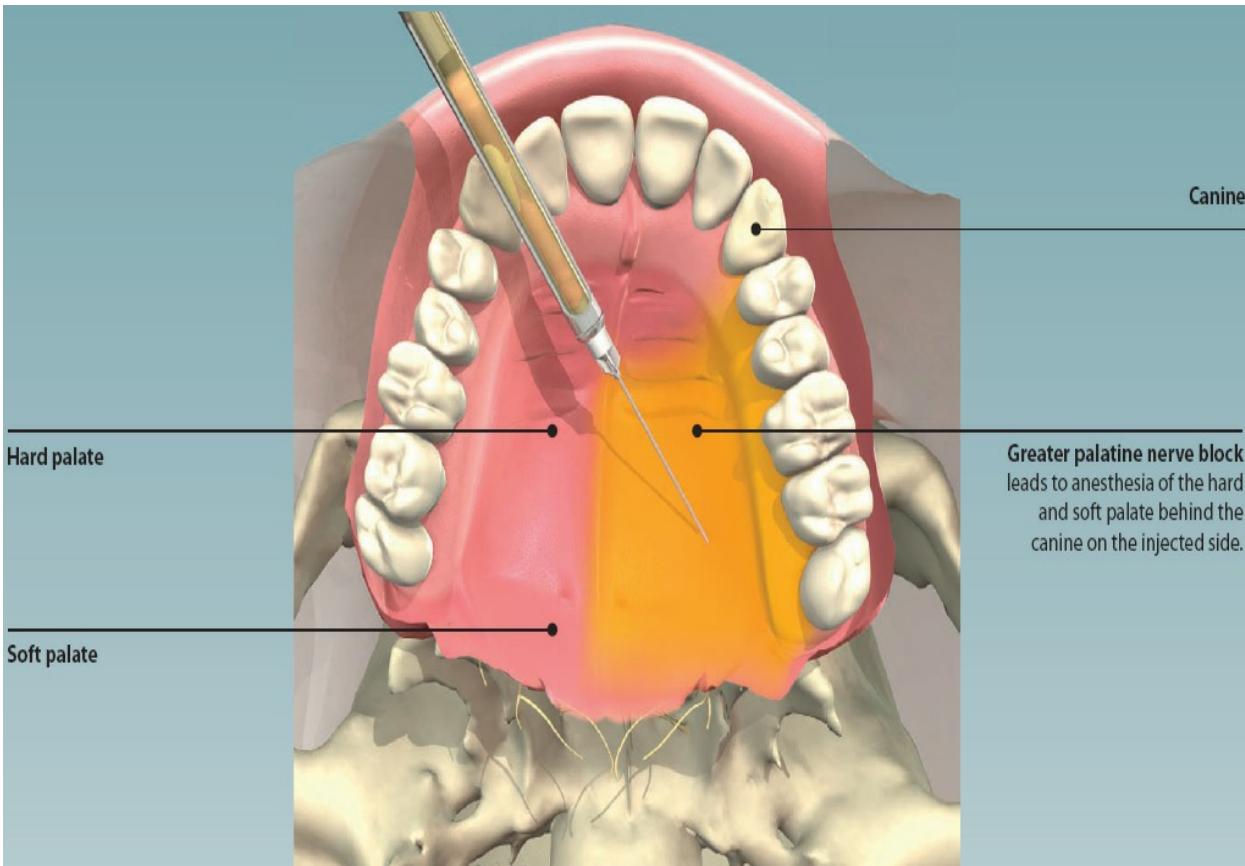


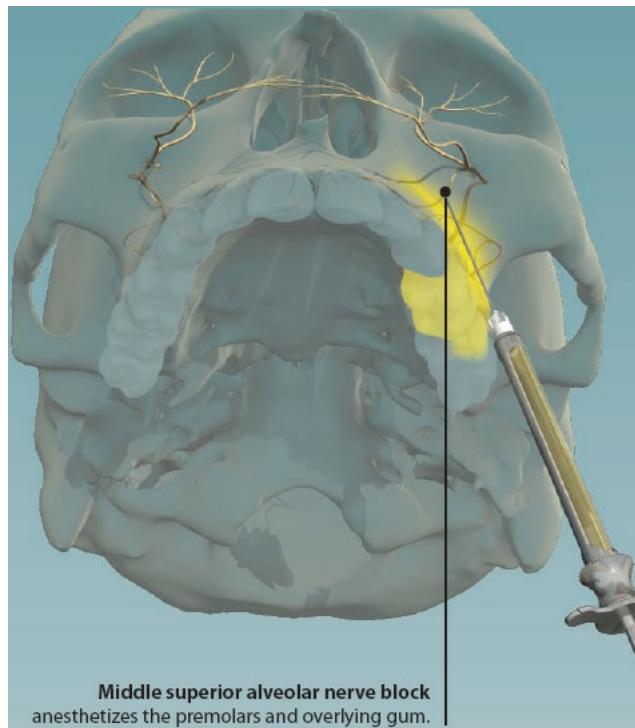
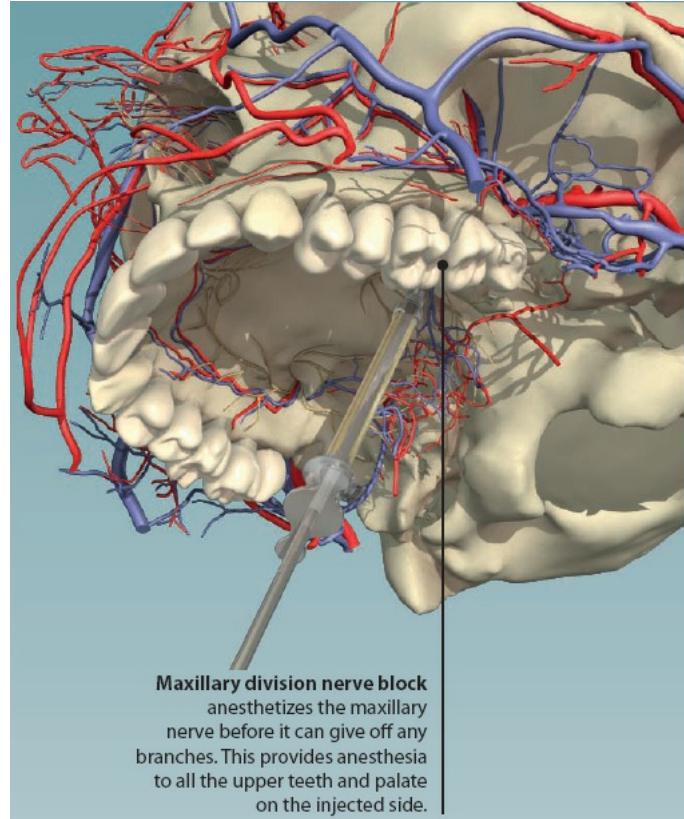
Restoration

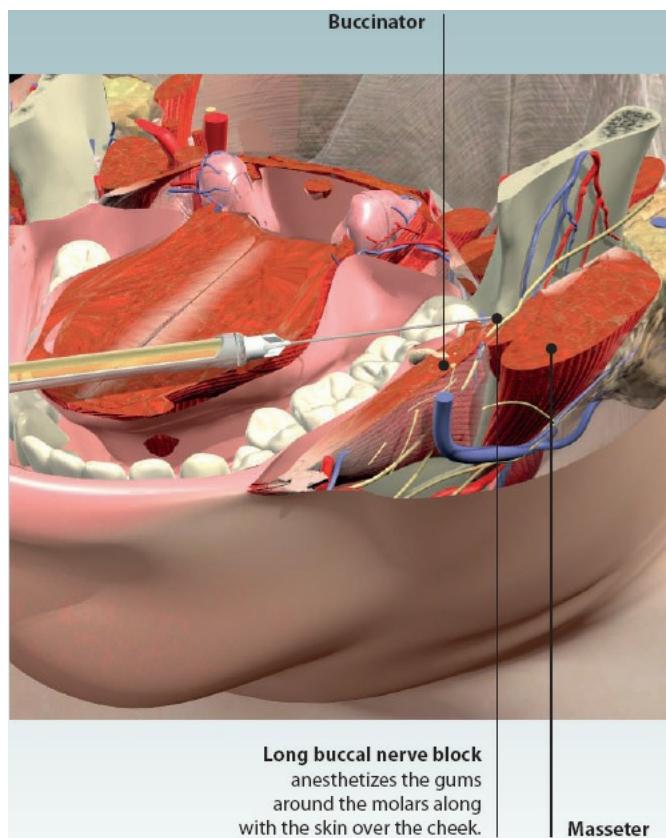
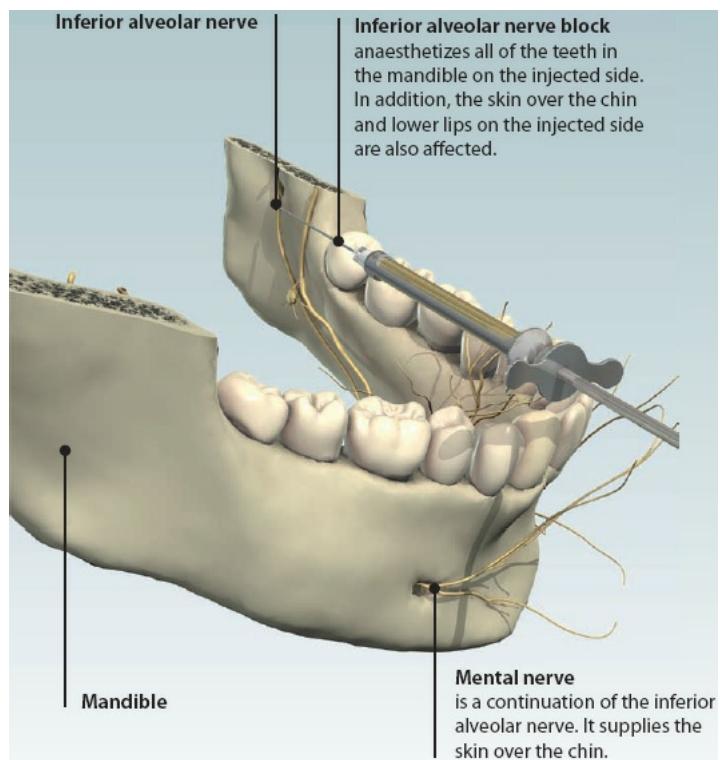
INTRAORAL INJECTIONS

The oral cavity and teeth are innervated by a number of different nerves. The transmission of pain sensation down these nerves can be blocked by injecting local anesthetic agents around them. This allows dental procedures to be carried out in a pain-free manner.

The choice of which intraoral injection to use depends mainly upon the area that needs to be pain free (anesthetized). All of these injections require excellent knowledge of the relevant anatomy to allow successful anesthesia.



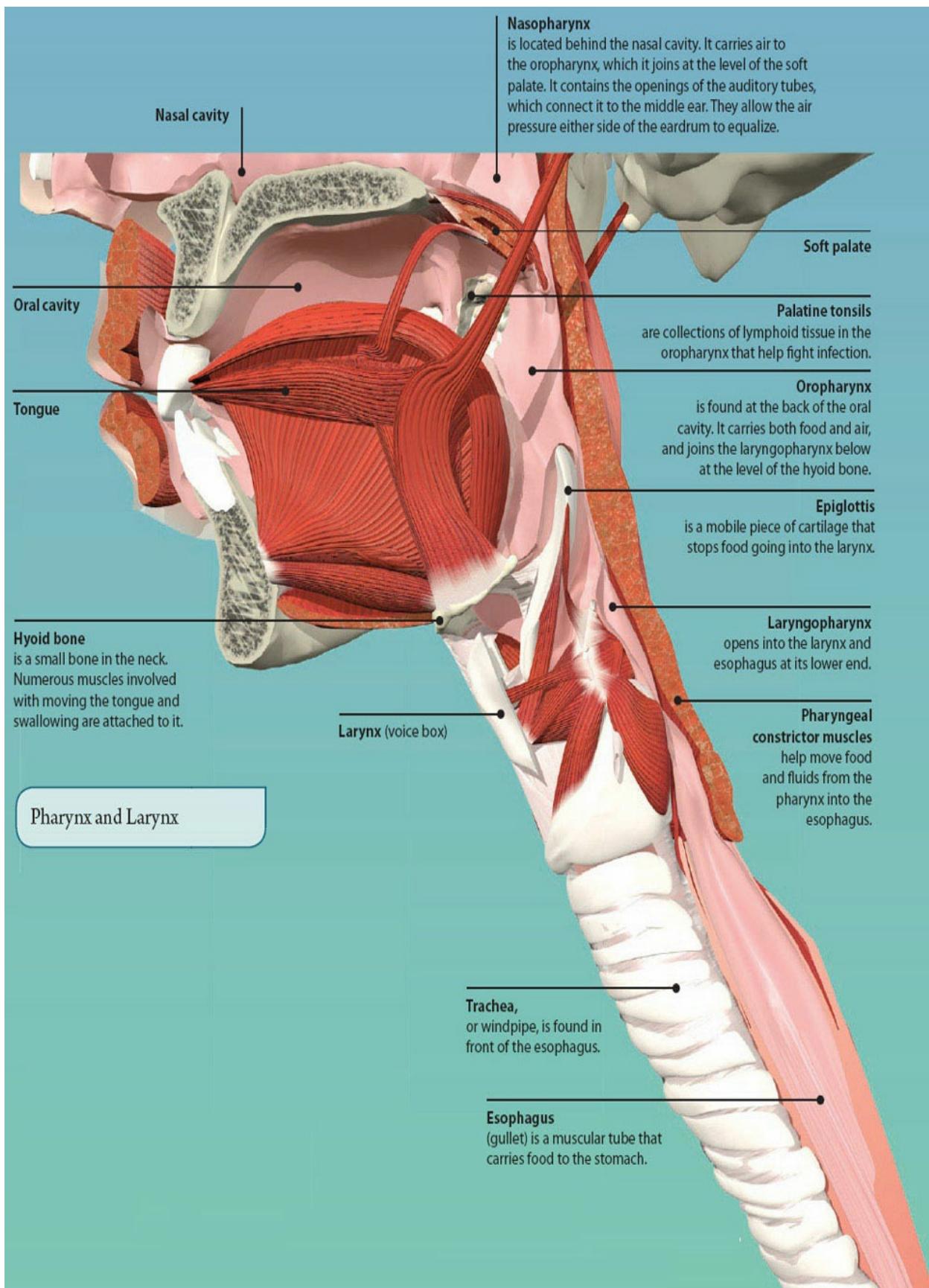


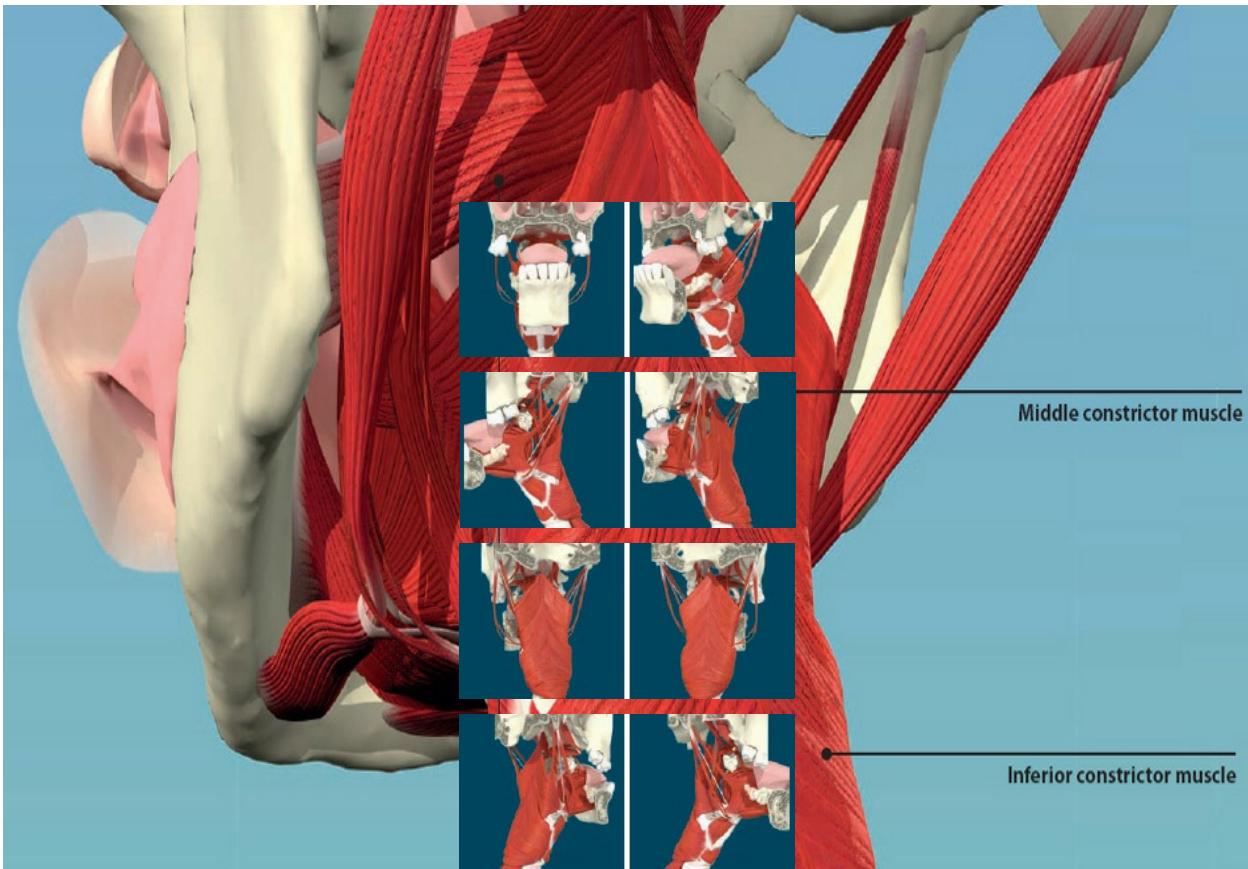


PHARYNX

The pharynx, or throat, is a muscular passageway for food, liquids, and air. It connects the oral and nasal cavities to the esophagus and larynx. The pharynx is divided into three sections: the nasopharynx, oropharynx, and laryngopharynx.

Three pharyngeal constrictor muscles form most of the pharyngeal walls. They partially overlap each other to form a muscular tube, which helps move food and fluid from the pharynx into the esophagus.





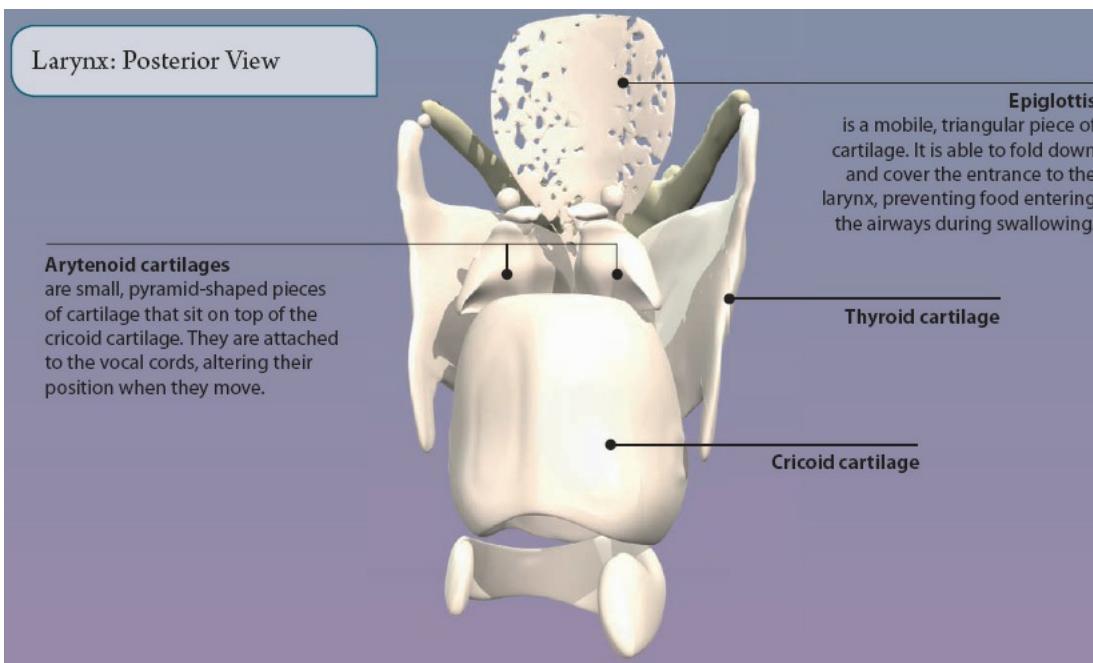
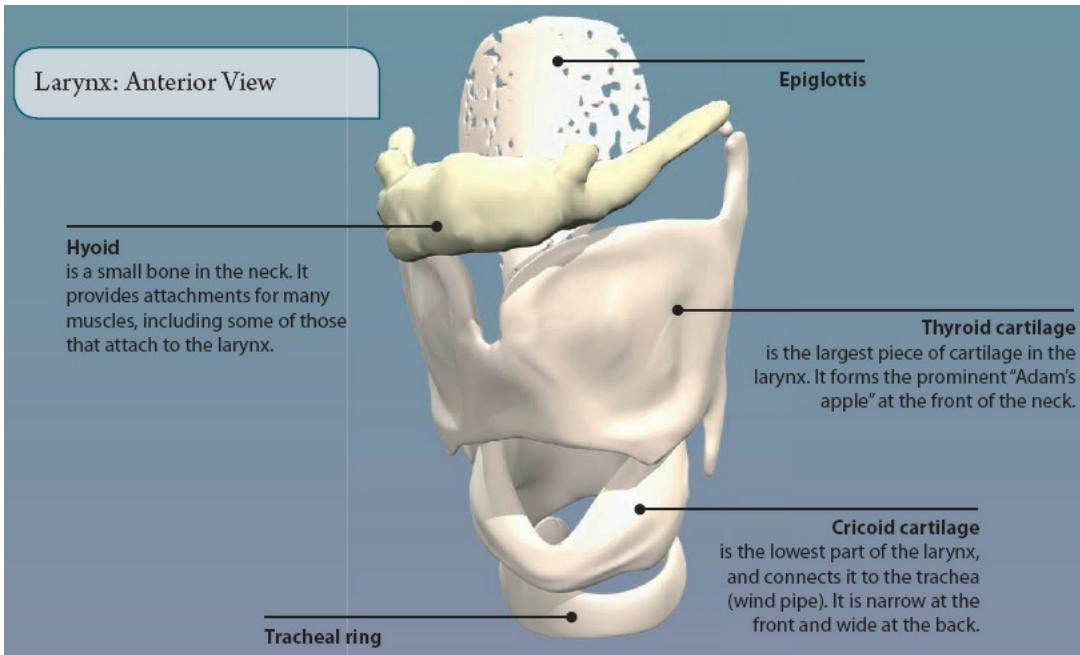
LARYNX

Superior constrictor muscle

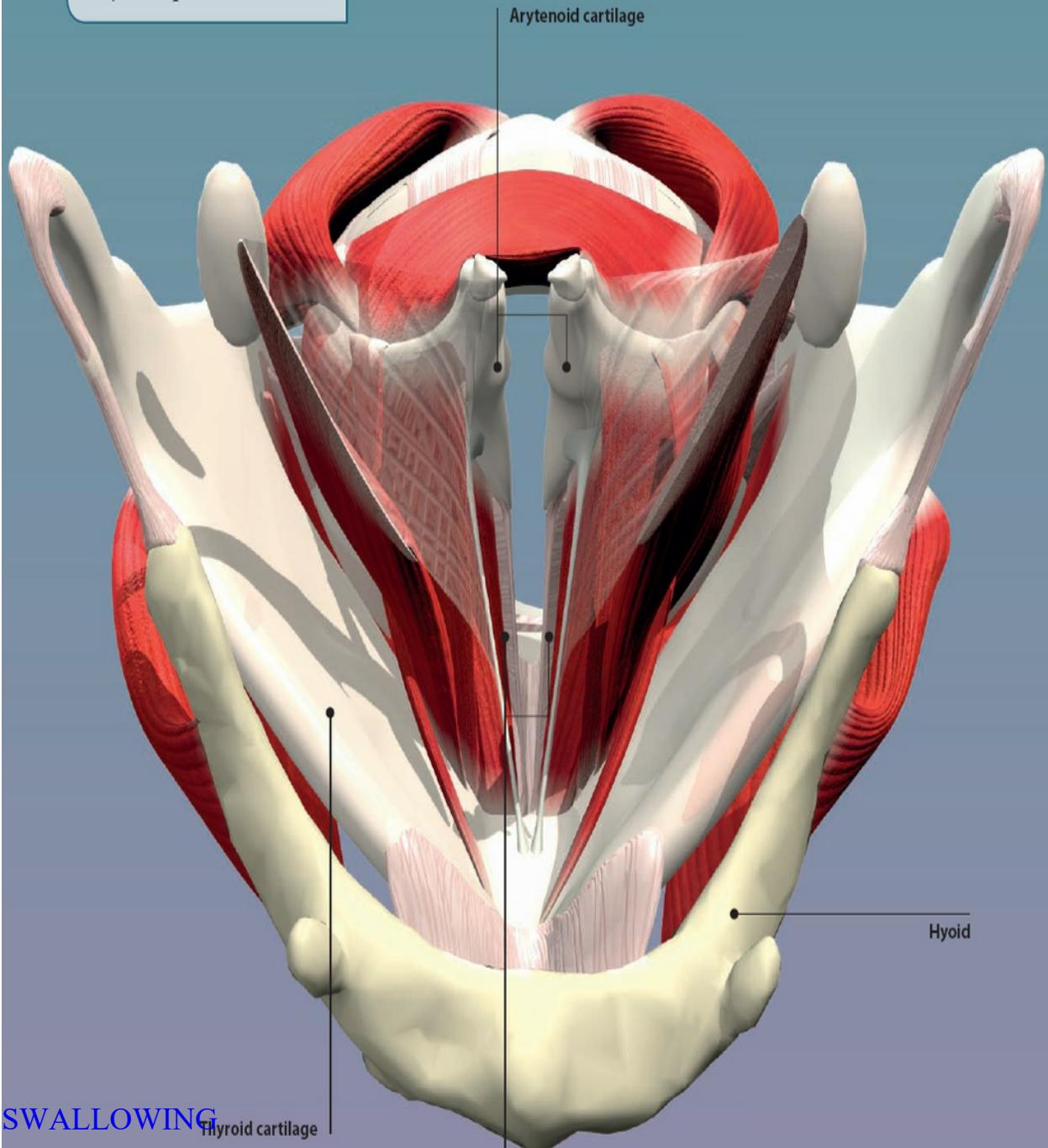
The larynx, or voice box, is found at the front of the neck. It is a short passageway through which air can move from the laryngopharynx into the trachea (wind pipe). It is made up of a number of separate pieces of cartilage, held together by connective tissue and muscles.

Paired pieces of tissue called “vocal folds” (or vocal cords) are attached between the cartilages of the larynx. Air passing between them causes them to vibrate and produce sounds that help us speak. Muscles that move the cartilage of the larynx alter the position and length of the vocal cords, to form sounds of different pitch.

Pharyngeal Muscles



Larynx: Superior View



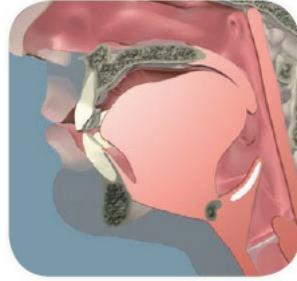
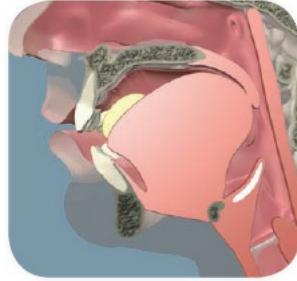
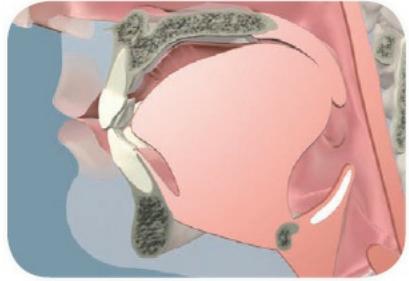
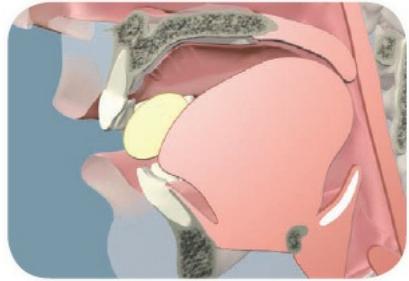
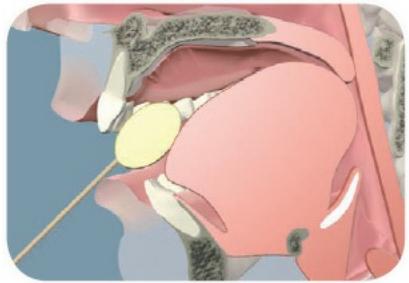
SWALLOWING

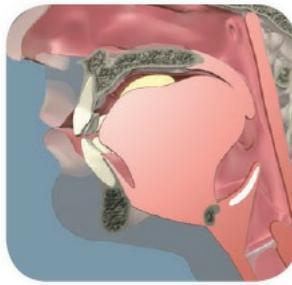
Thyroid cartilage

Swallowing is the process by which food and fluids are moved from the mouth to the stomach. It involves the coordinated contraction of muscles of the tongue, soft palate, pharynx, larynx, and esophagus. The process is controlled by the nervous system. There are three phases to swallowing: oral, pharyngeal, and esophageal.

Stage 1

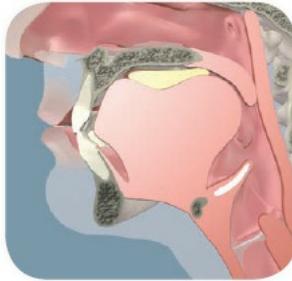
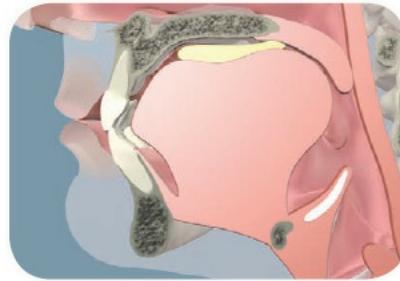
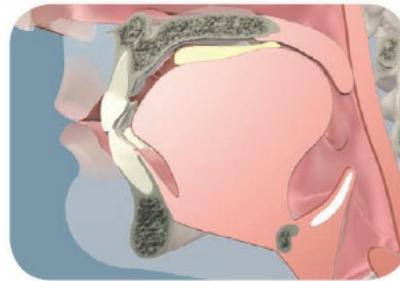
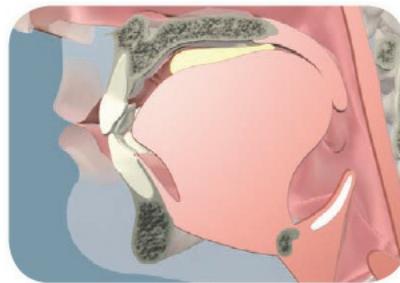
Vocal folds are closed. Air passes between the arytenoid cartilage. Vibrations caused by air passing between them generates sounds that we use to help us speak.

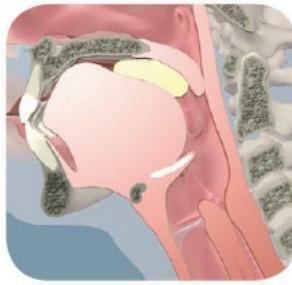
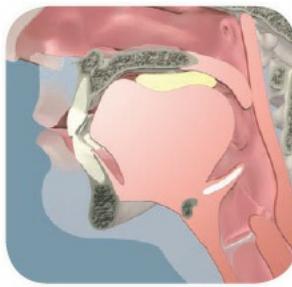




Within the mouth, food is chewed, broken down, and mixed with saliva. The **tongue** moves the food around the mouth and by pressing it against the **hard palate** forms a compact **food bolus**.

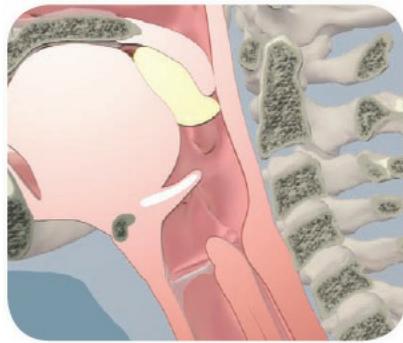
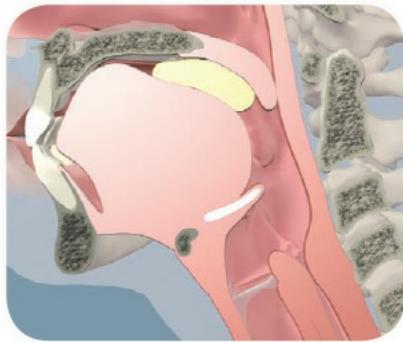
Stage 2

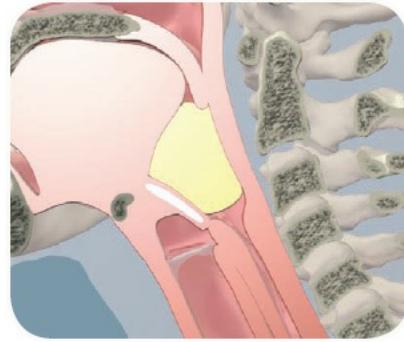
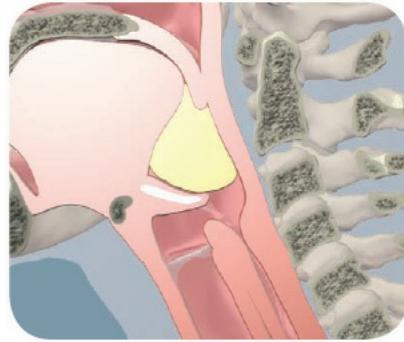
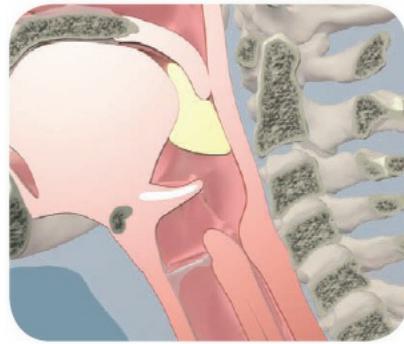




The oral phase of swallowing is under voluntary control. The tongue moves upward and backward; compressing the food bolus against the hard and soft palate, and propelling the food bolus into the **oropharynx**.

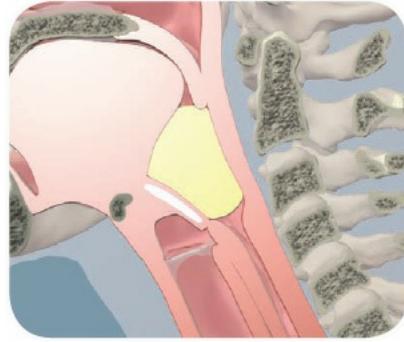
Stage 3

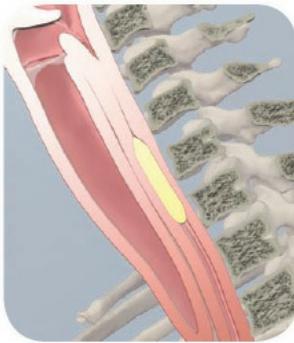
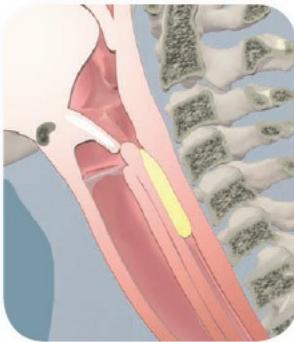
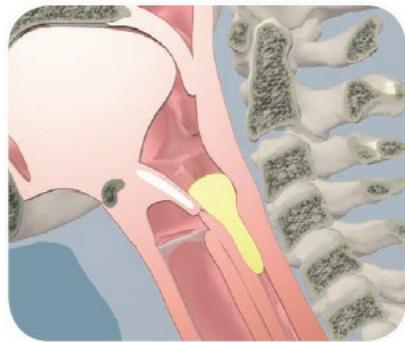
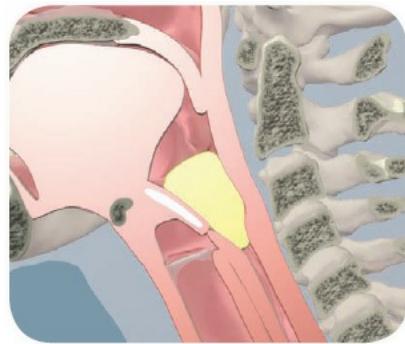




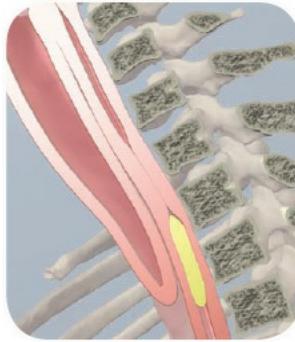
The pharyngeal phase is not under conscious voluntary control. When the food bolus enters the oropharynx, the swallowing center in the brainstem triggers a reflex contraction of muscles of the soft palate, pharynx, and larynx. They move the bolus through the pharynx to the esophagus opening. The soft palate moves upward to prevent food entering the nasopharynx. The epiglottis folds down and larynx moves up, preventing food from entering the trachea.

Stage 4





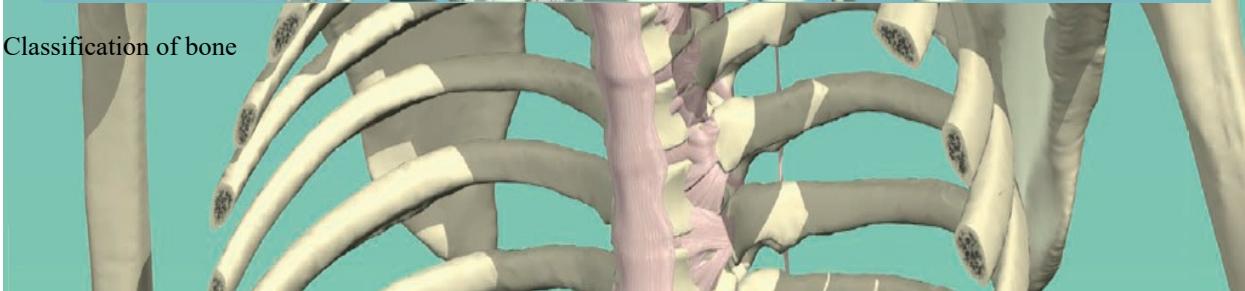
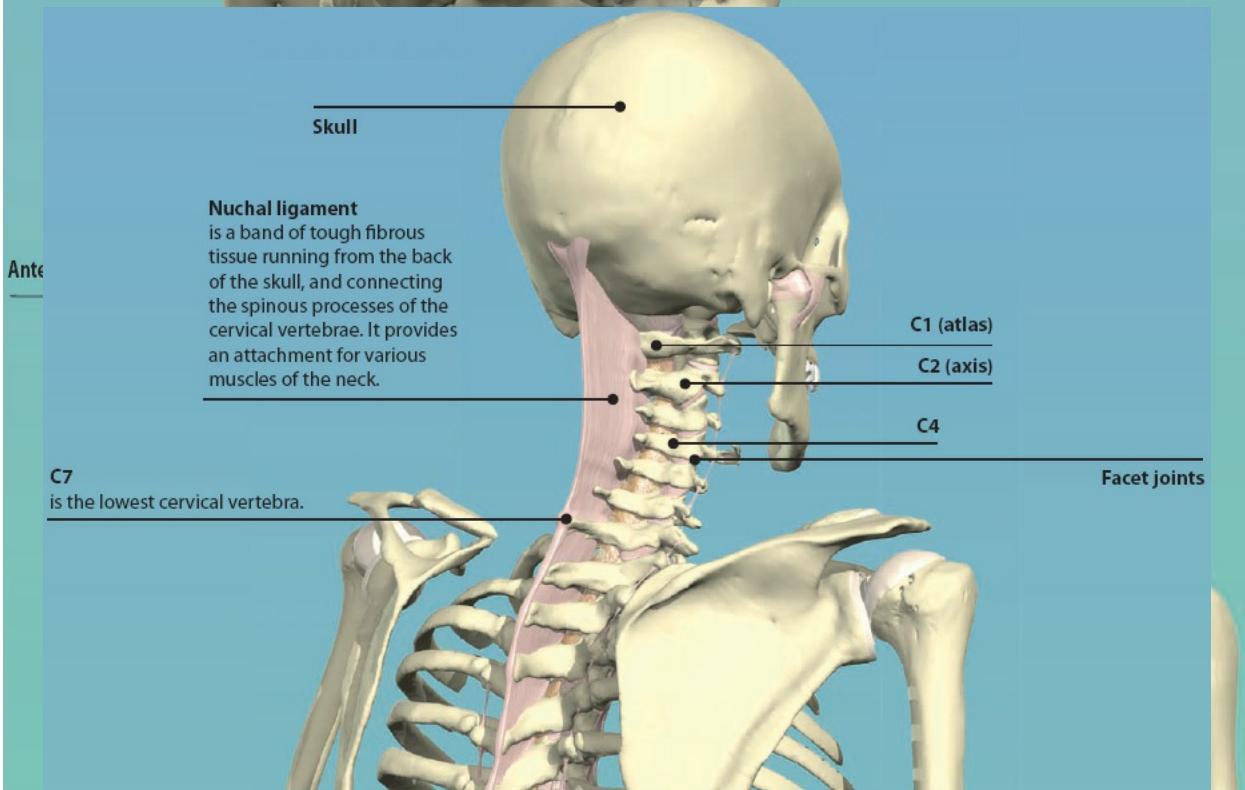
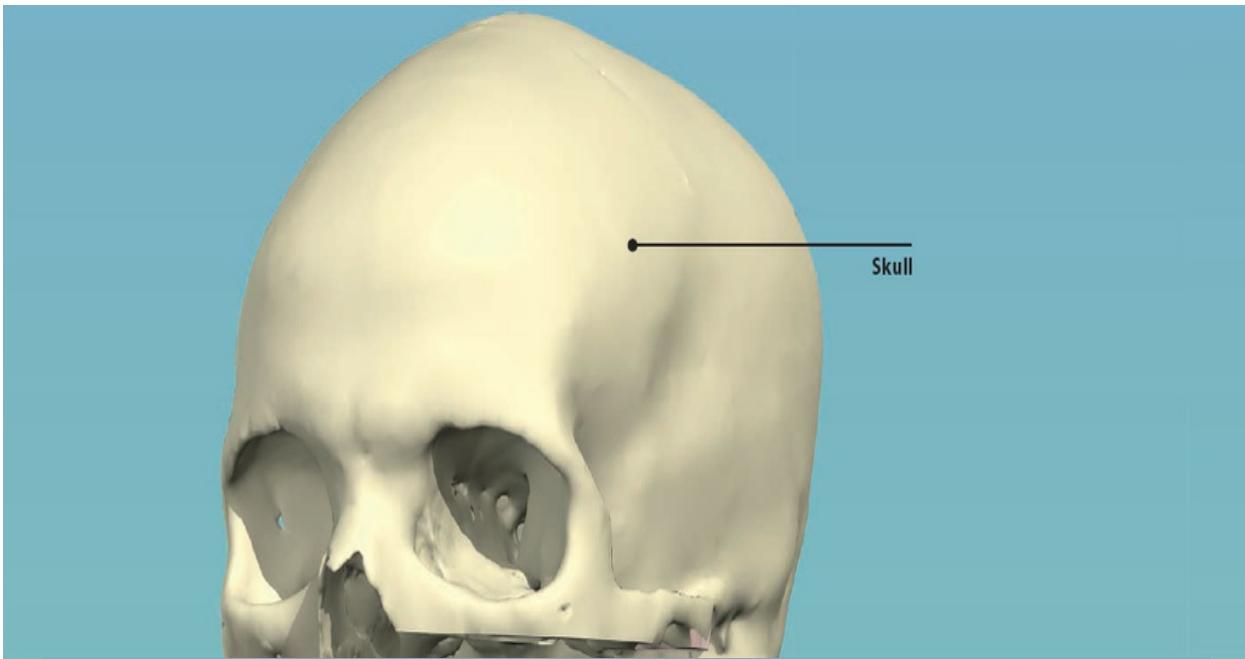
The esophageal phase is also involuntary. A series of coordinated wave-like muscle contractions (**peristaltic waves**) sweep the food bolus down the **esophagus** and into the stomach. This process is known as peristalsis.

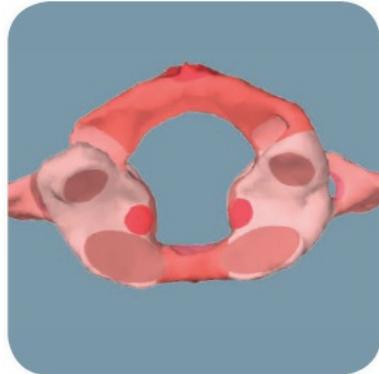


BONES OF THE NECK

The skull is supported by seven bones called cervical vertebrae (referred to as C1 to C7). They form the highest section of the vertebral column. The vertebrae are stacked on top of each other, forming a canal through which the spinal cord can run.

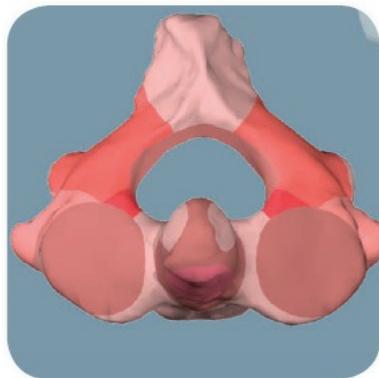
They allow the head to move in a variety of directions: bending forward and backward and side to side, and rotating the head both left and right.





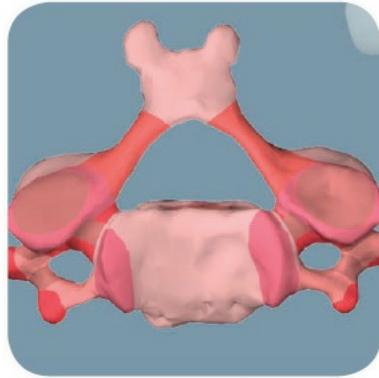
C1 (atlas)

supports the skull on its two large **lateral masses**. It does not have a body like the other vertebrae.



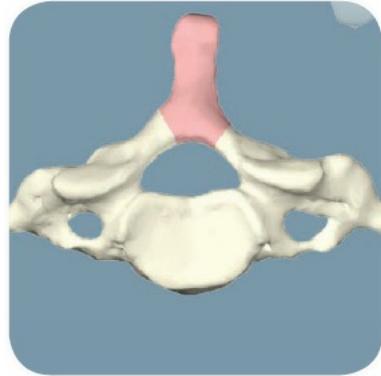
C2 (axis)

has a vertical projection called the **dens**. This acts as both a body and pivot for the atlas to rotate around.



C4

is a typical cervical vertebra. It has a bifid (two-pronged) **spinous process**, a **body**, a **vertebral canal**, and **facet joints** for connecting with the vertebrae above and below it.

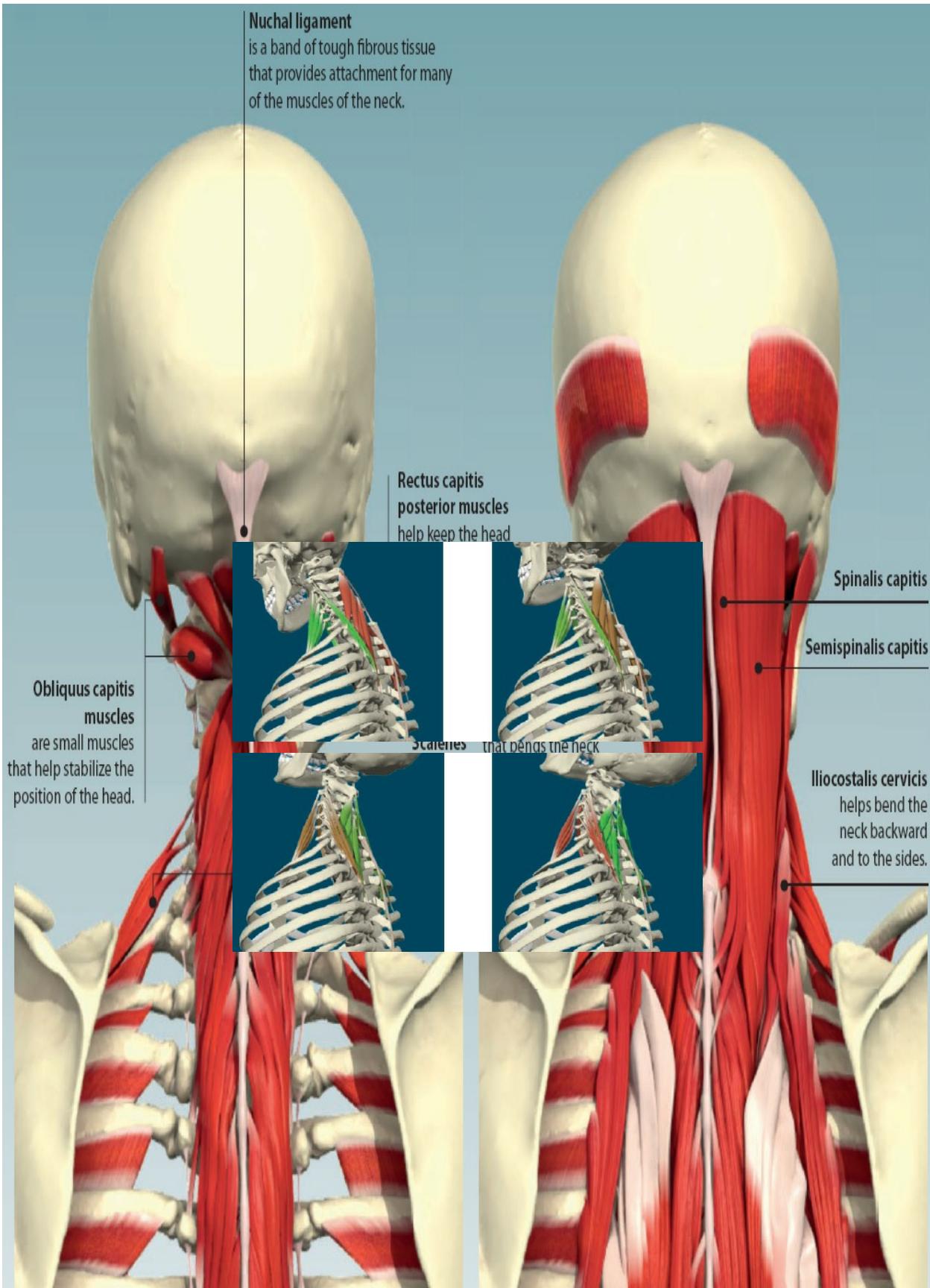


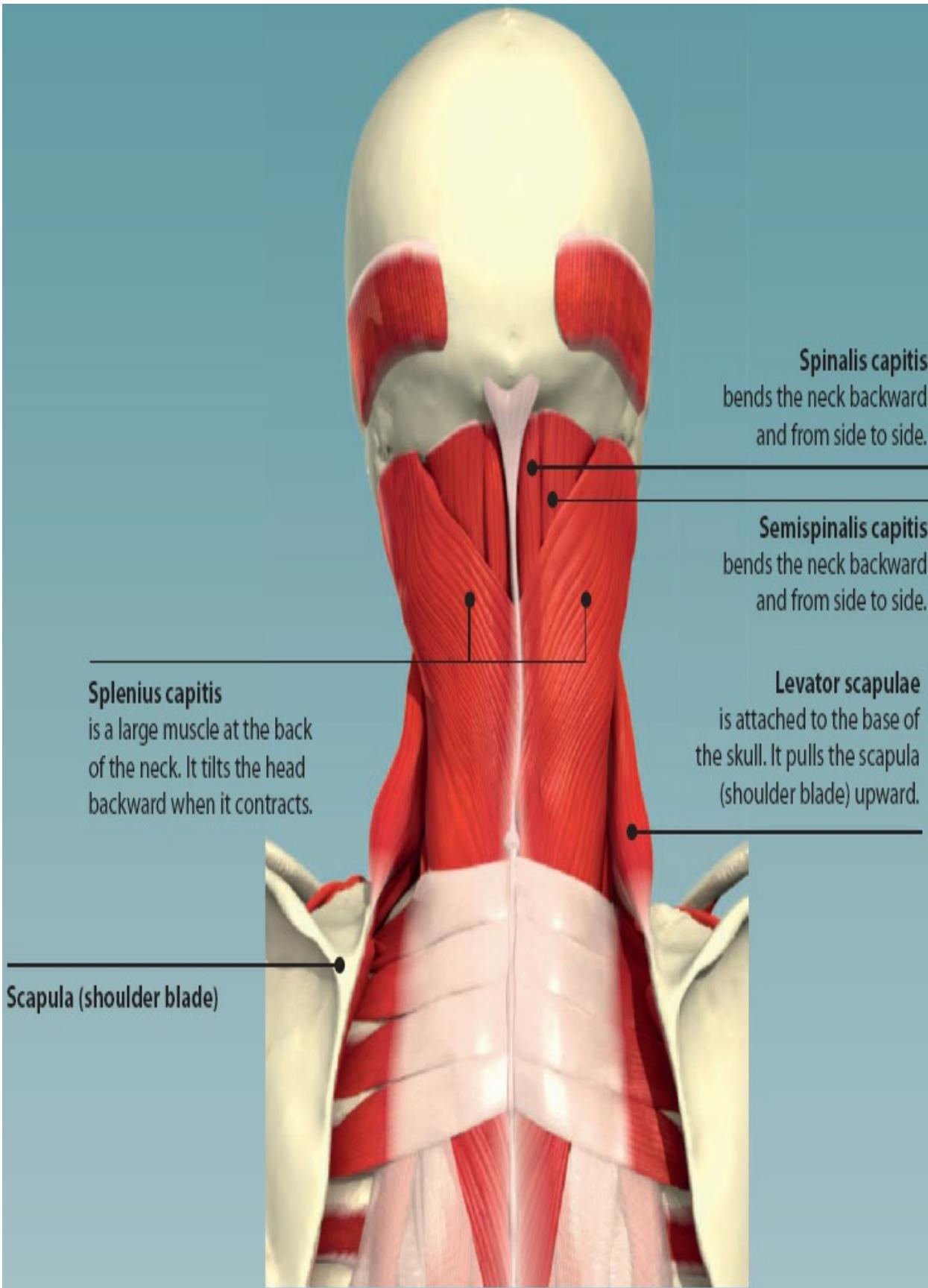
C7

is the lowest bone in the neck. It has an elongated **spinous process** that can be easily felt at the back of the neck.

MUSCLES OF THE NECK

Movements of the neck and the position of the head are controlled by a large number of muscles. Stability and fine adjustment tends to be performed by the small muscles found deep within the neck. The large muscles closer to the skin surface are involved with bending the neck forwards, backwards, and side to side, as well as turning it to the left and right.





Spinalis capitis

bends the neck backward
and from side to side.

Semispinalis capitis

bends the neck backward
and from side to side.

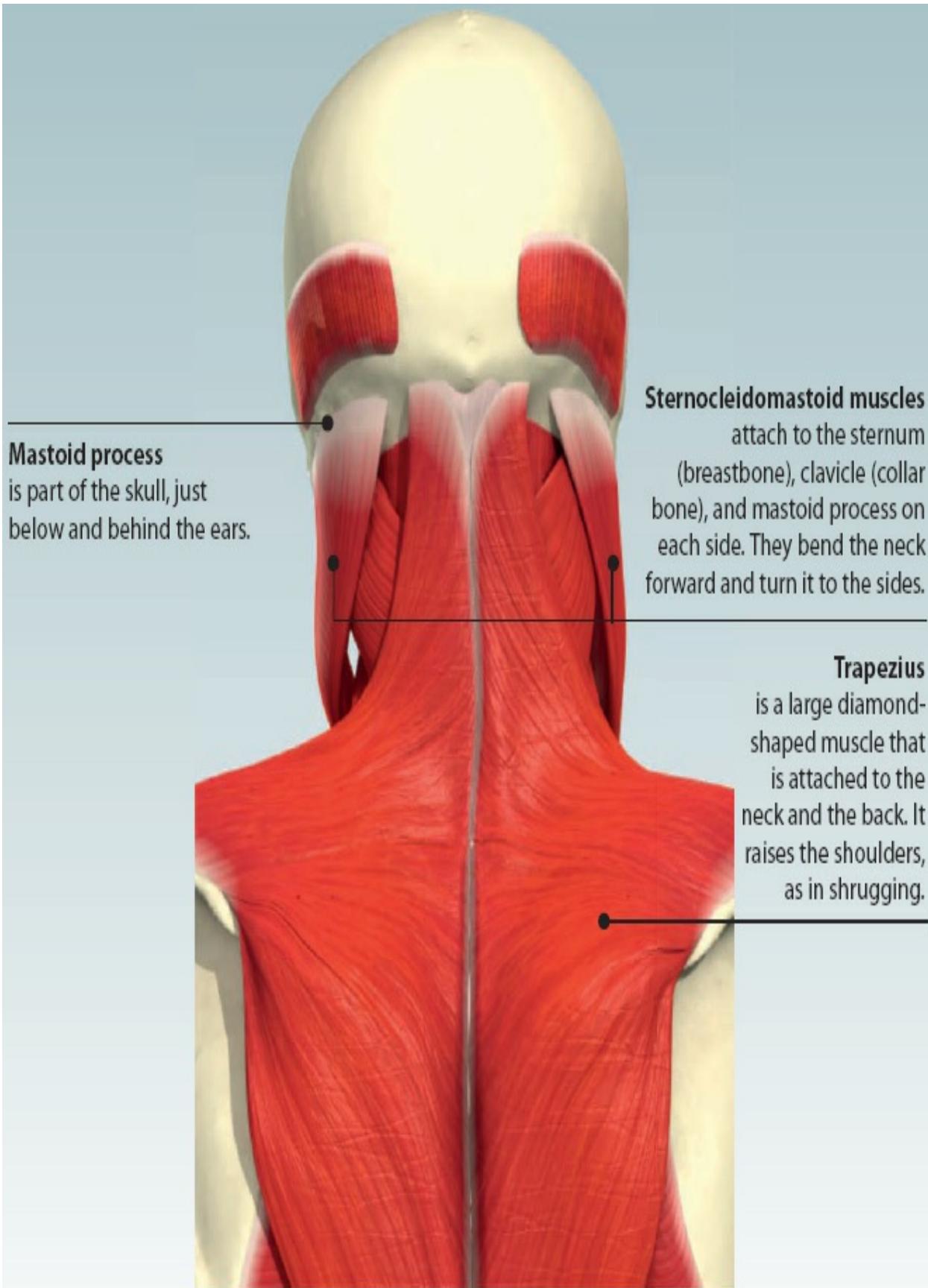
Splenius capitis

is a large muscle at the back
of the neck. It tilts the head
backward when it contracts.

Levator scapulae

is attached to the base of
the skull. It pulls the scapula
(shoulder blade) upward.

Scapula (shoulder blade)



Mastoid process

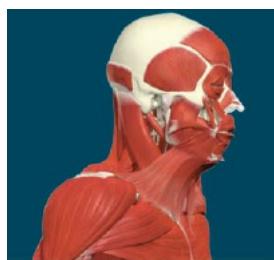
is part of the skull, just below and behind the ears.

Sternocleidomastoid muscles

attach to the sternum (breastbone), clavicle (collar bone), and mastoid process on each side. They bend the neck forward and turn it to the sides.

Trapezium

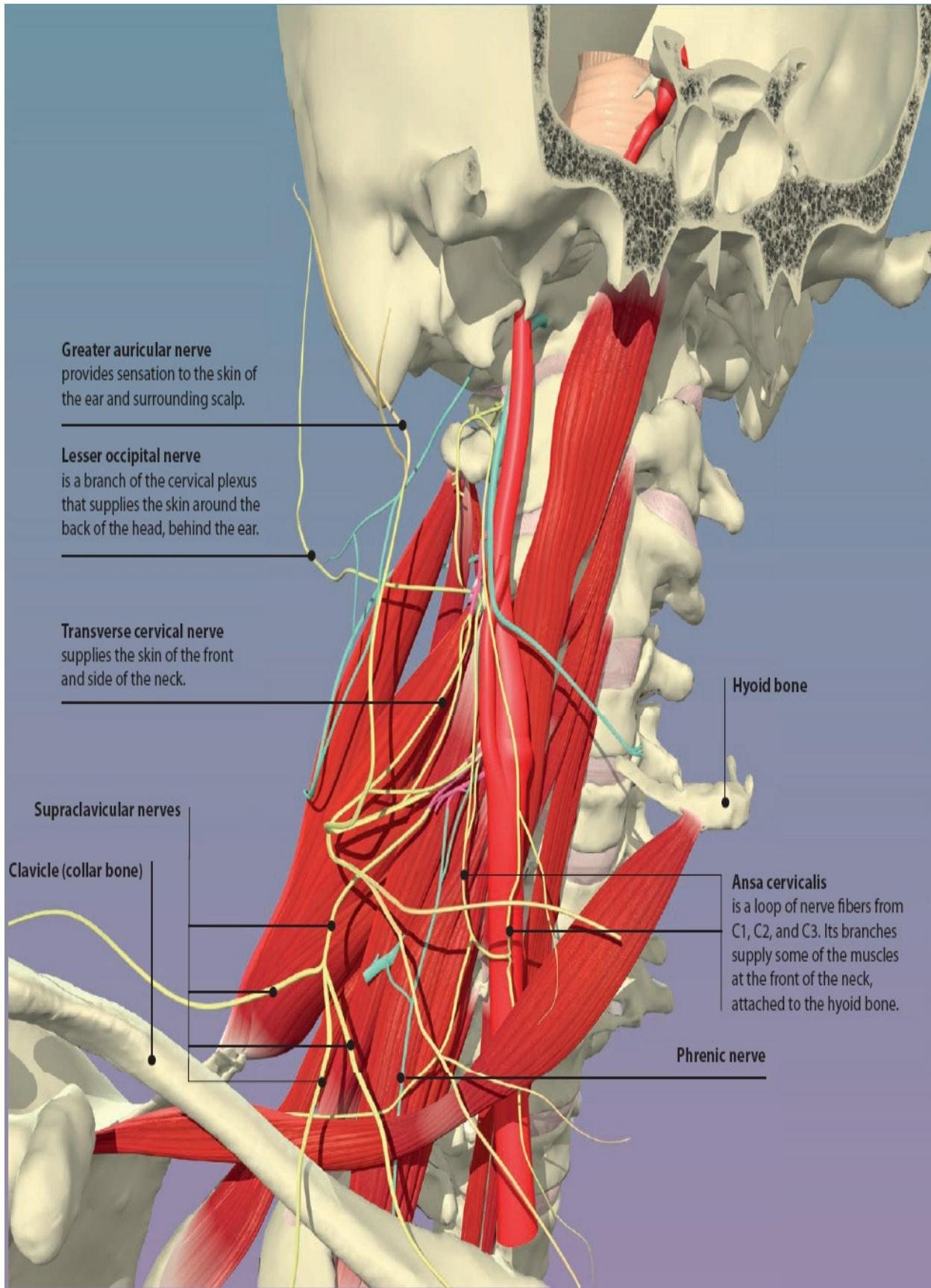
is a large diamond-shaped muscle that is attached to the neck and the back. It raises the shoulders, as in shrugging.

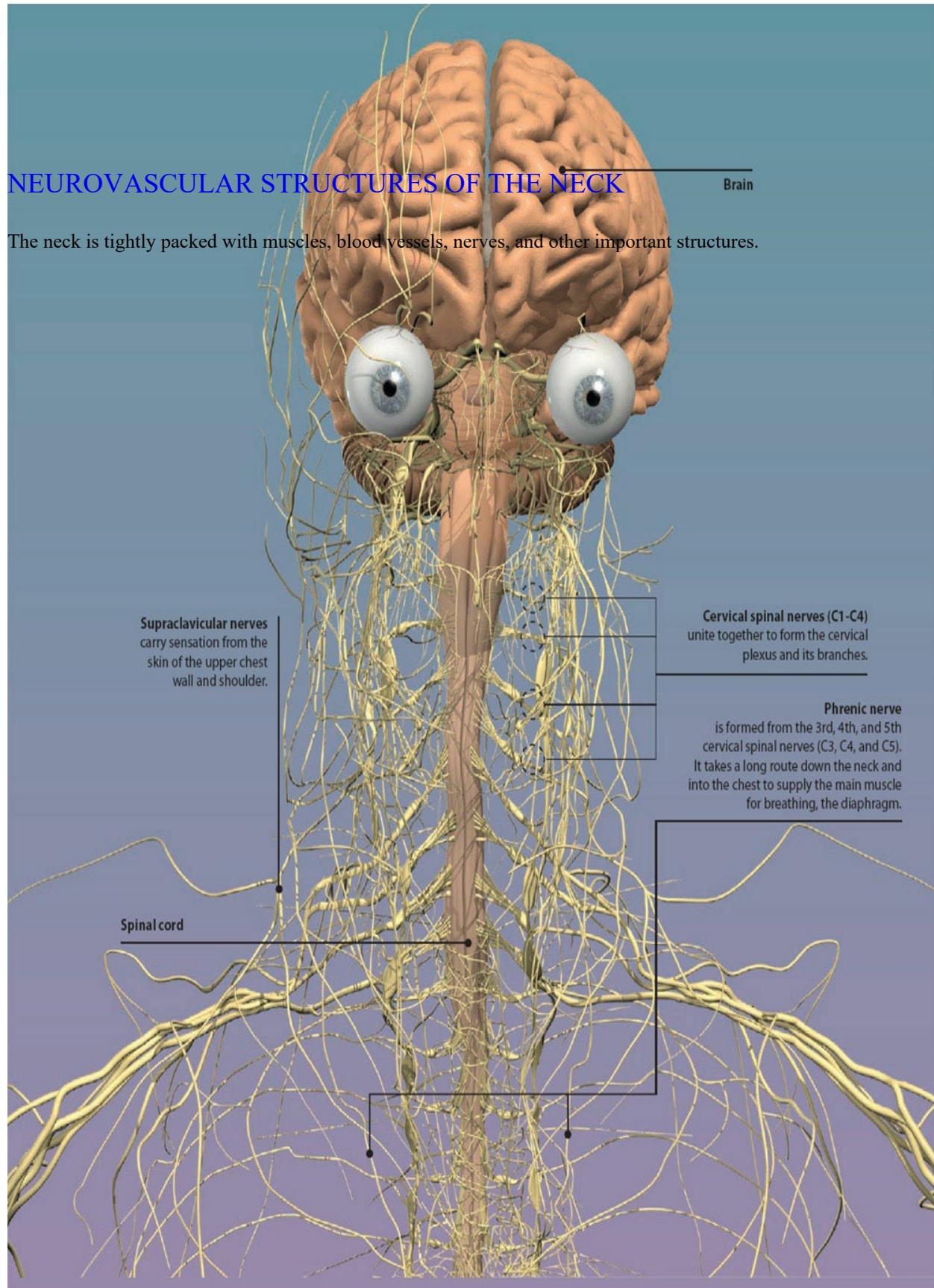


CERVICAL PLEXUS

Individual nerves from different levels of the spinal cord join together to form a network of fibers. This is called a plexus. Branches from the plexus then supply the skin and muscles of a specific area.

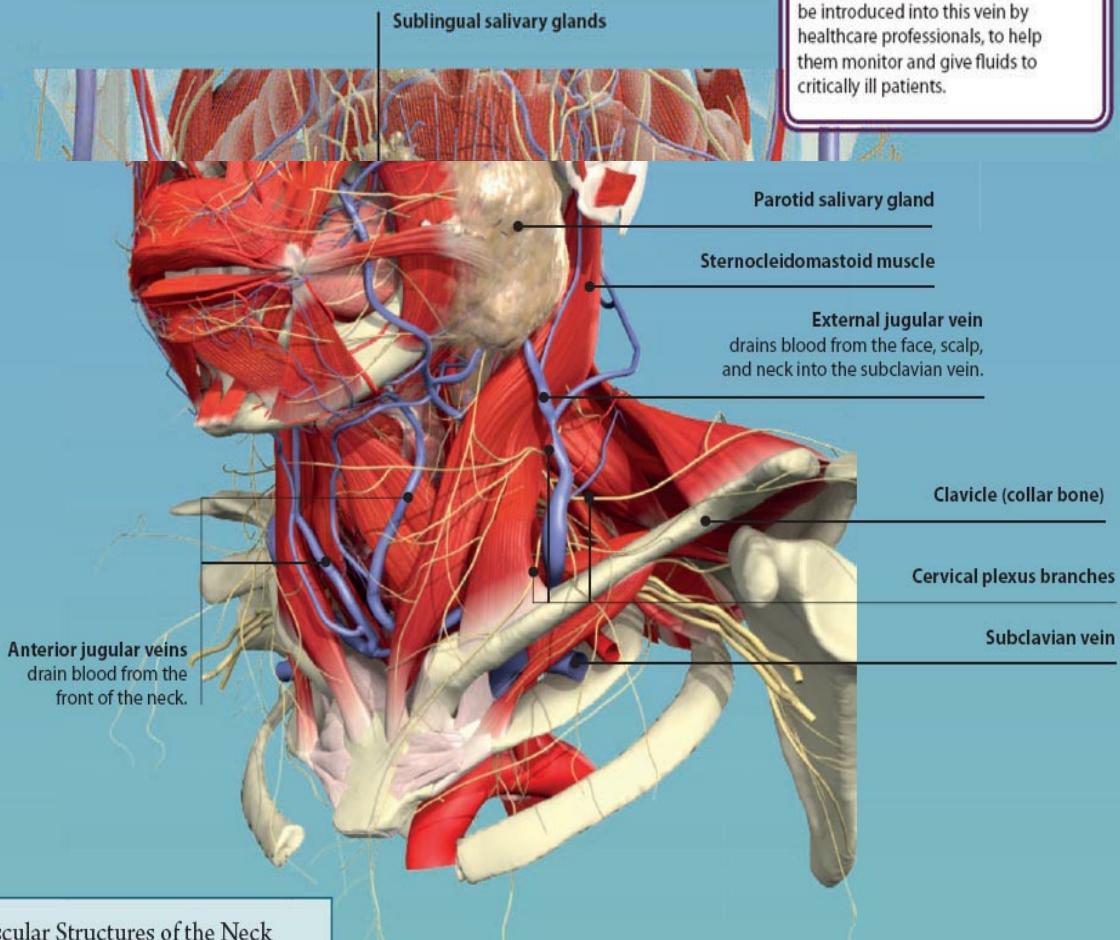
The cervical plexus is formed from the upper four spinal nerves in the neck (cervical nerves C1-C4). The plexus gives off nerve branches that supply the skin of the shoulders, neck and scalp, the muscles at the front of the neck, as well as the diaphragm, the main muscle that helps us breathe.



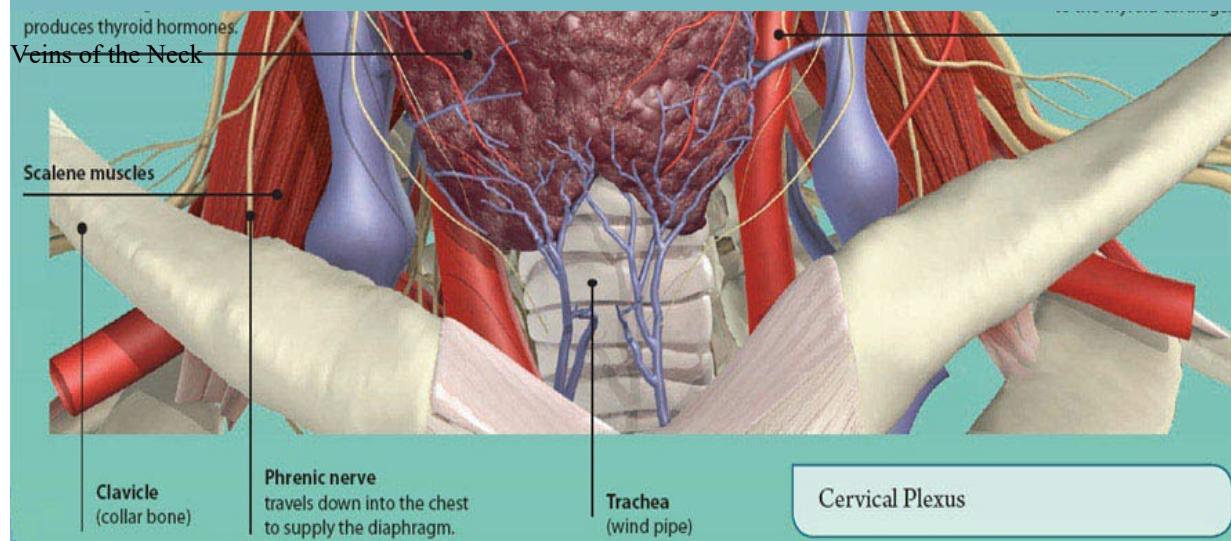


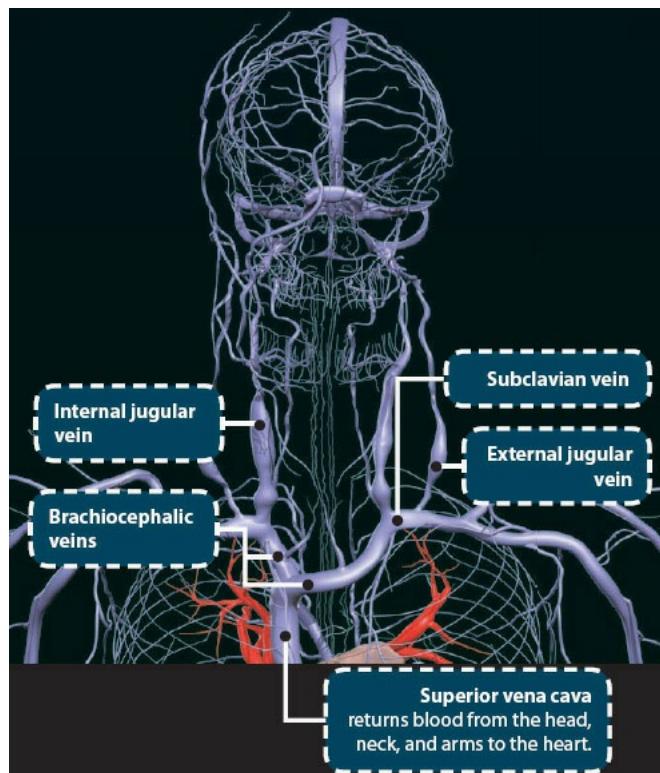
Did you know?

The internal jugular vein is fairly consistent in position between individuals. Large tubes called central venous catheters can be introduced into this vein by healthcare professionals, to help them monitor and give fluids to critically ill patients.

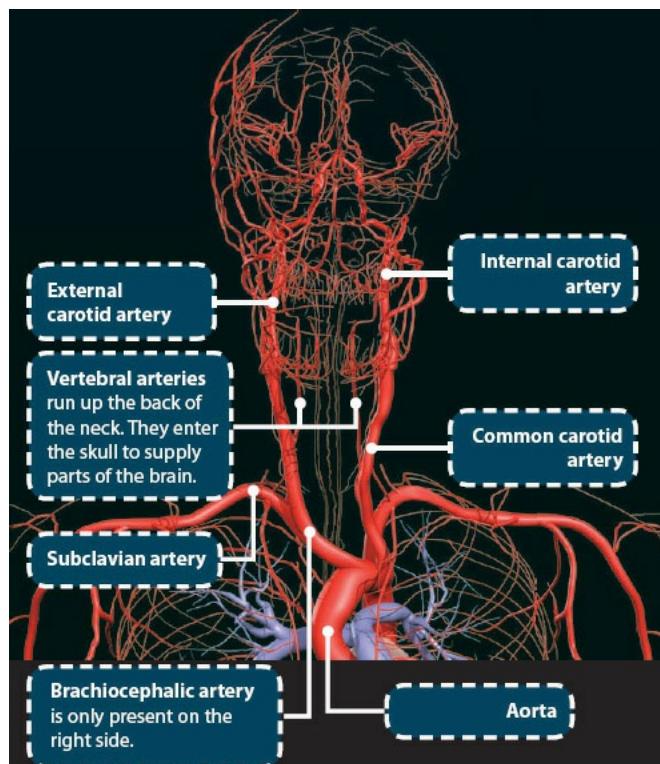


Neurovascular Structures of the Neck





Arteries of the Neck



CHAPTER 3: THE BACK

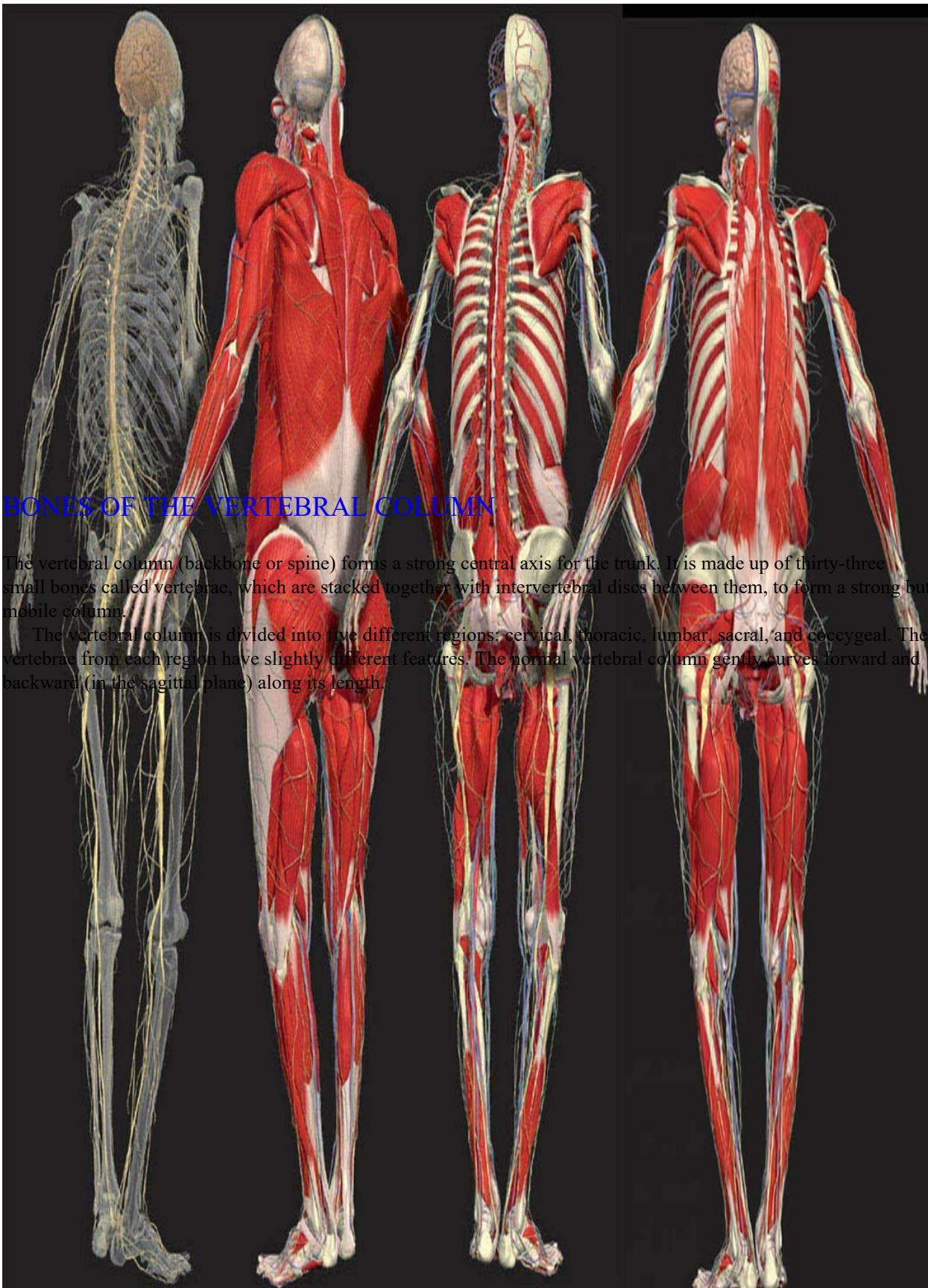
The central part of the body between the neck and the hips is known as the trunk.

The rear most part of this area, which provides the trunk with structure and support, is called the back.

The vertebral column (spine or backbone) forms most of the bony framework of the back, with contributions from the ribs, shoulder blades, and pelvis. It is made up of a number of small bones called vertebrae, which are stacked together to form a chain. This arrangement gives strength to the spine, while still allowing it to move.

Numerous muscles are attached to the vertebral column. They help us keep a good posture, and allow us to bend and twist the spine.

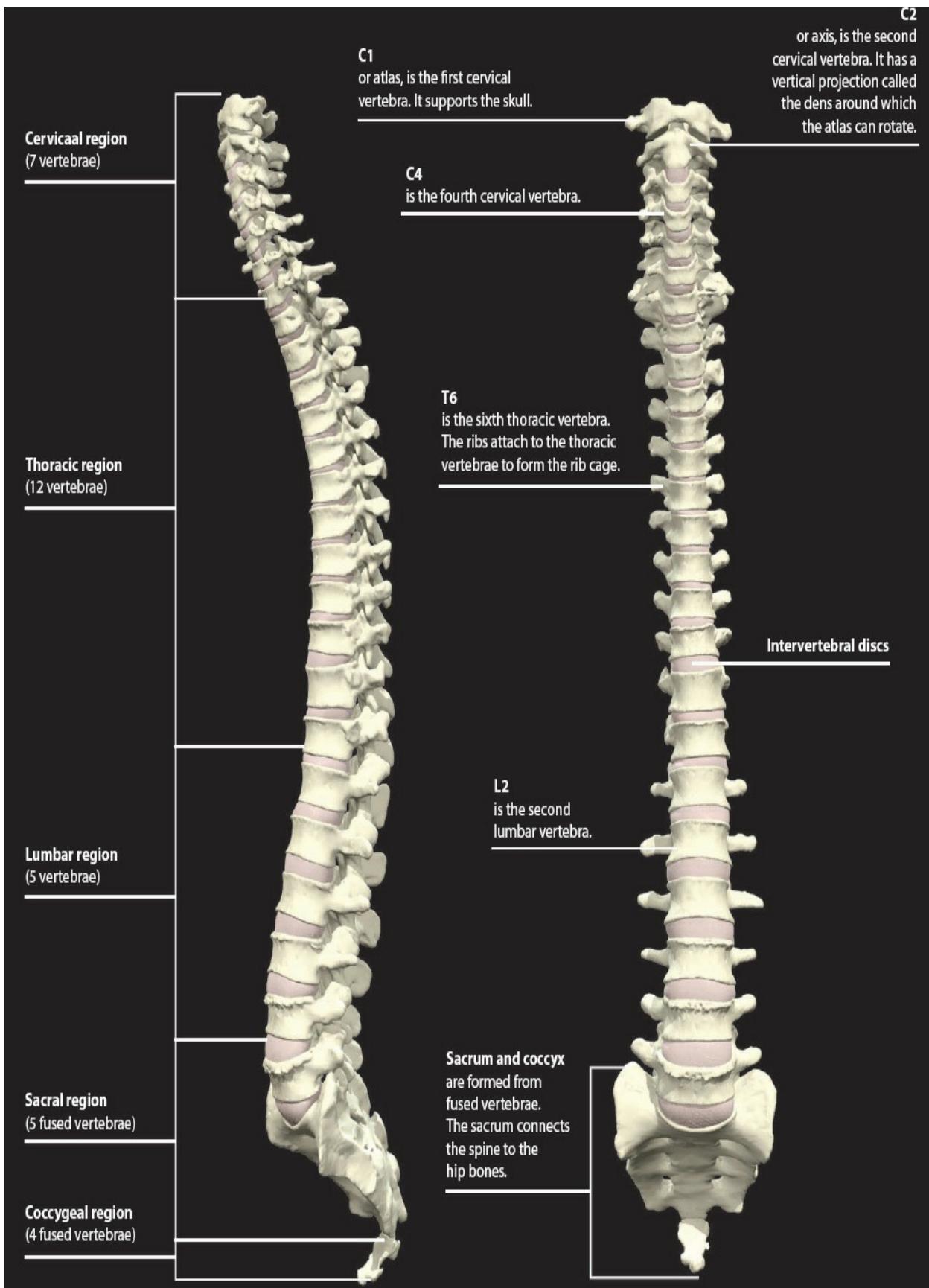
Running through the center of the vertebral column, and protected by it, is the spinal cord. This vital structure relays nerve signals between the brain and rest of the body. Spinal nerves leave the spinal cord at different levels to supply the body.



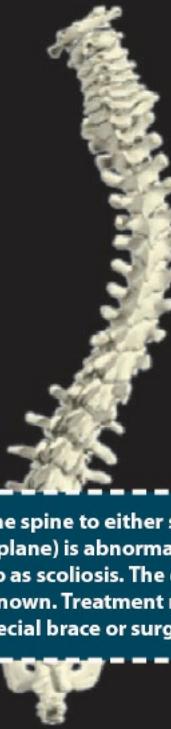
BONES OF THE VERTEBRAL COLUMN

The vertebral column (backbone or spine) forms a strong central axis for the trunk. It is made up of thirty-three small bones called vertebrae, which are stacked together with intervertebral discs between them, to form a strong but mobile column.

The vertebral column is divided into five different regions: cervical, thoracic, lumbar, sacral, and coccygeal. The vertebrae from each region have slightly different features. The normal vertebral column gently curves forward and backward (in the sagittal plane) along its length.

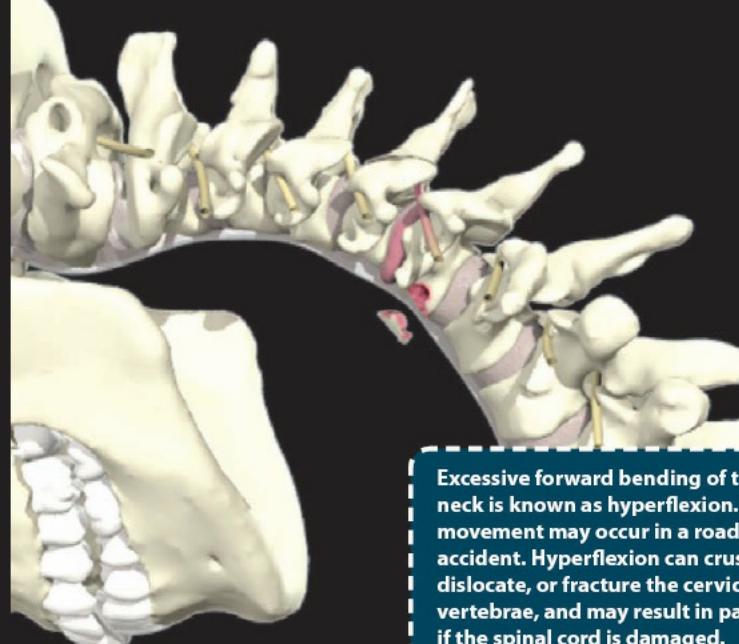


Scoliosis



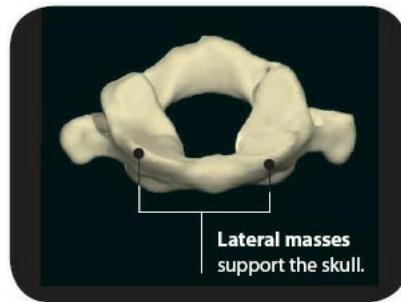
A curve of the spine to either side (in the coronal plane) is abnormal, and is referred to as scoliosis. The cause is often unknown. Treatment may involve a special brace or surgery.

Hyperflexion

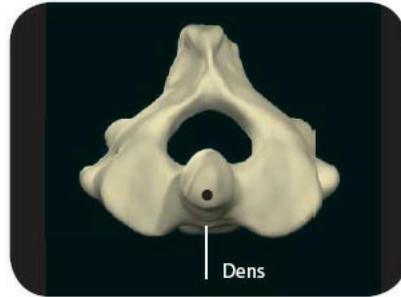


Excessive forward bending of the neck is known as hyperflexion. This movement may occur in a road traffic accident. Hyperflexion can crush, dislocate, or fracture the cervical vertebrae, and may result in paralysis if the spinal cord is damaged.

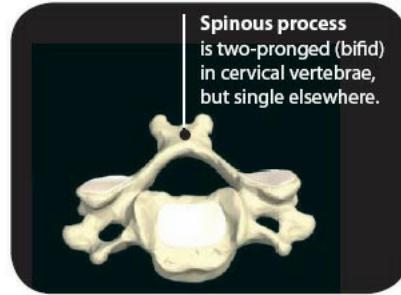
Classification of bone



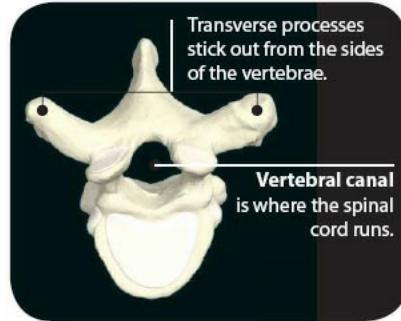
C1 (atlas)



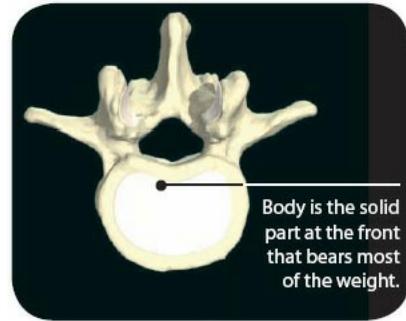
C2



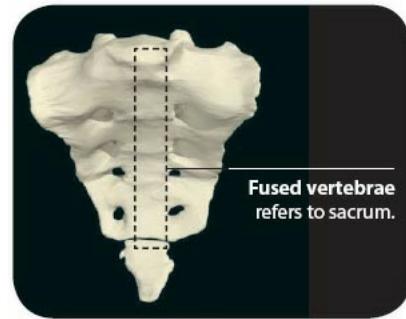
C4



T6



L2

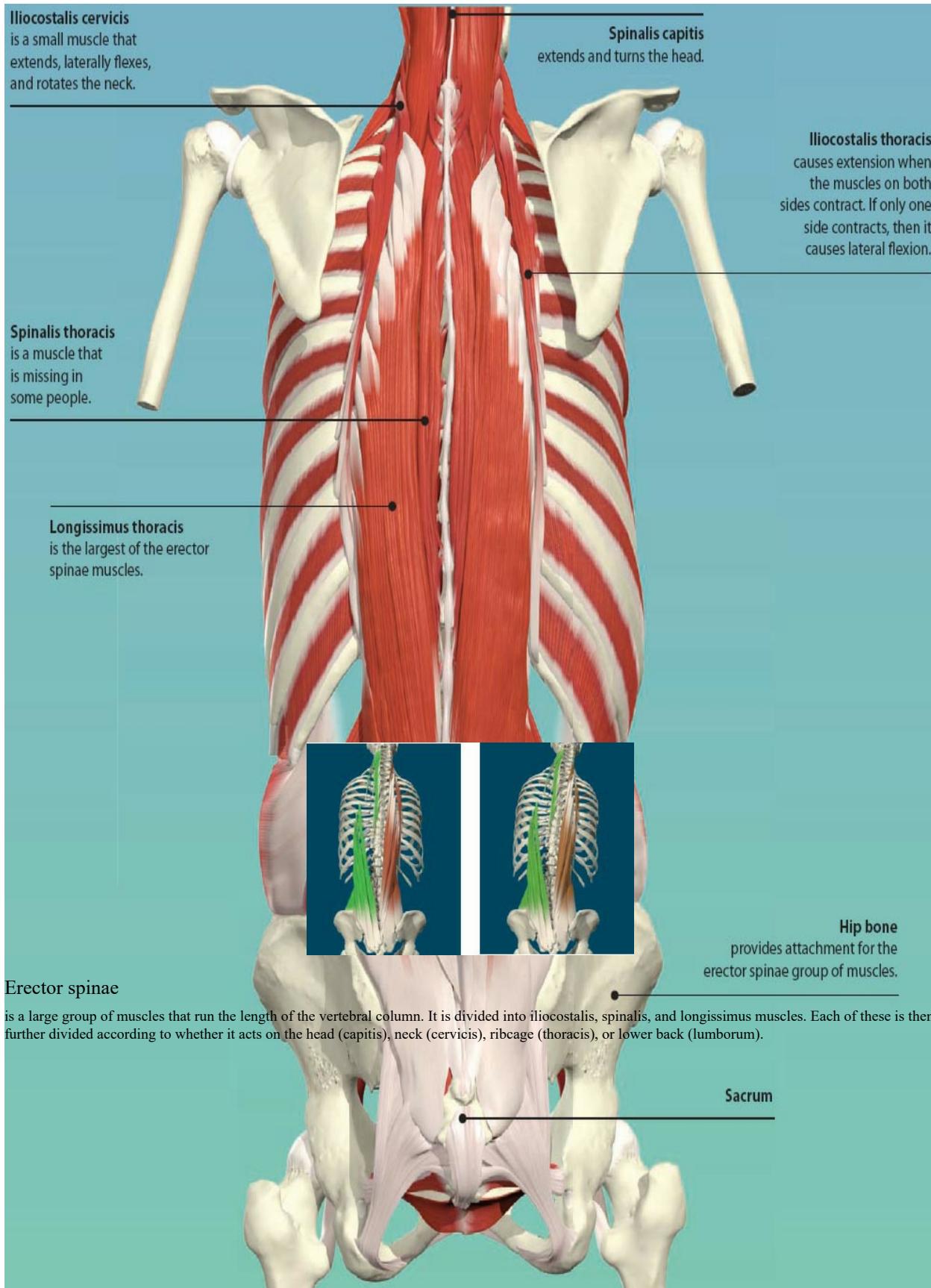


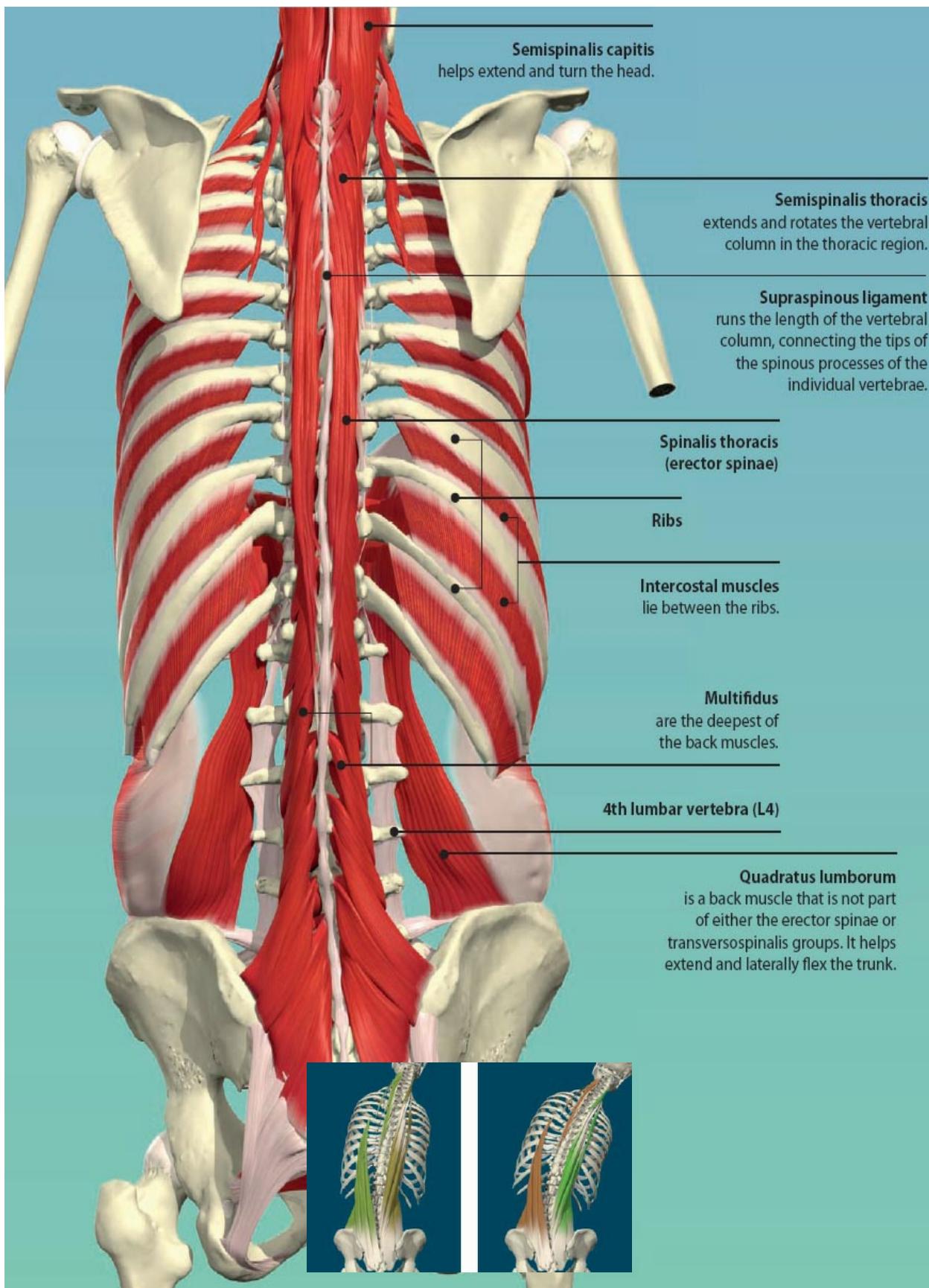
Sacrum and Coccyx

MUSCLES OF THE BACK

The back has a large number of muscles, running either side of the vertebral column.

Working together, they allow us to straighten our back (extension), bend to the sides (lateral flexion), and twist from side to side (rotation).









Transversospinalis

is the other large group of back muscles. It is made up of the semispinalis and multifidus muscles.

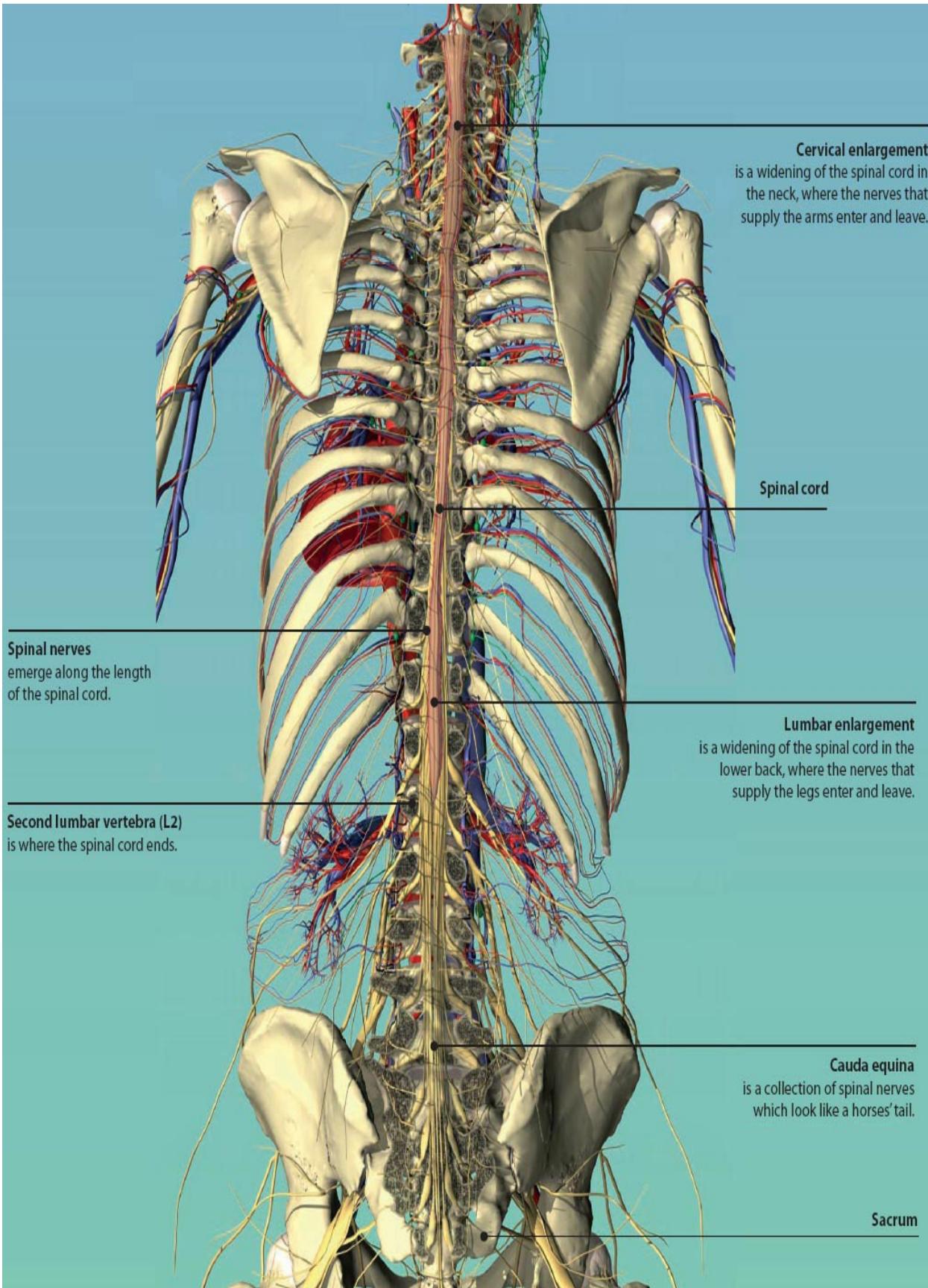
SPINAL CORD

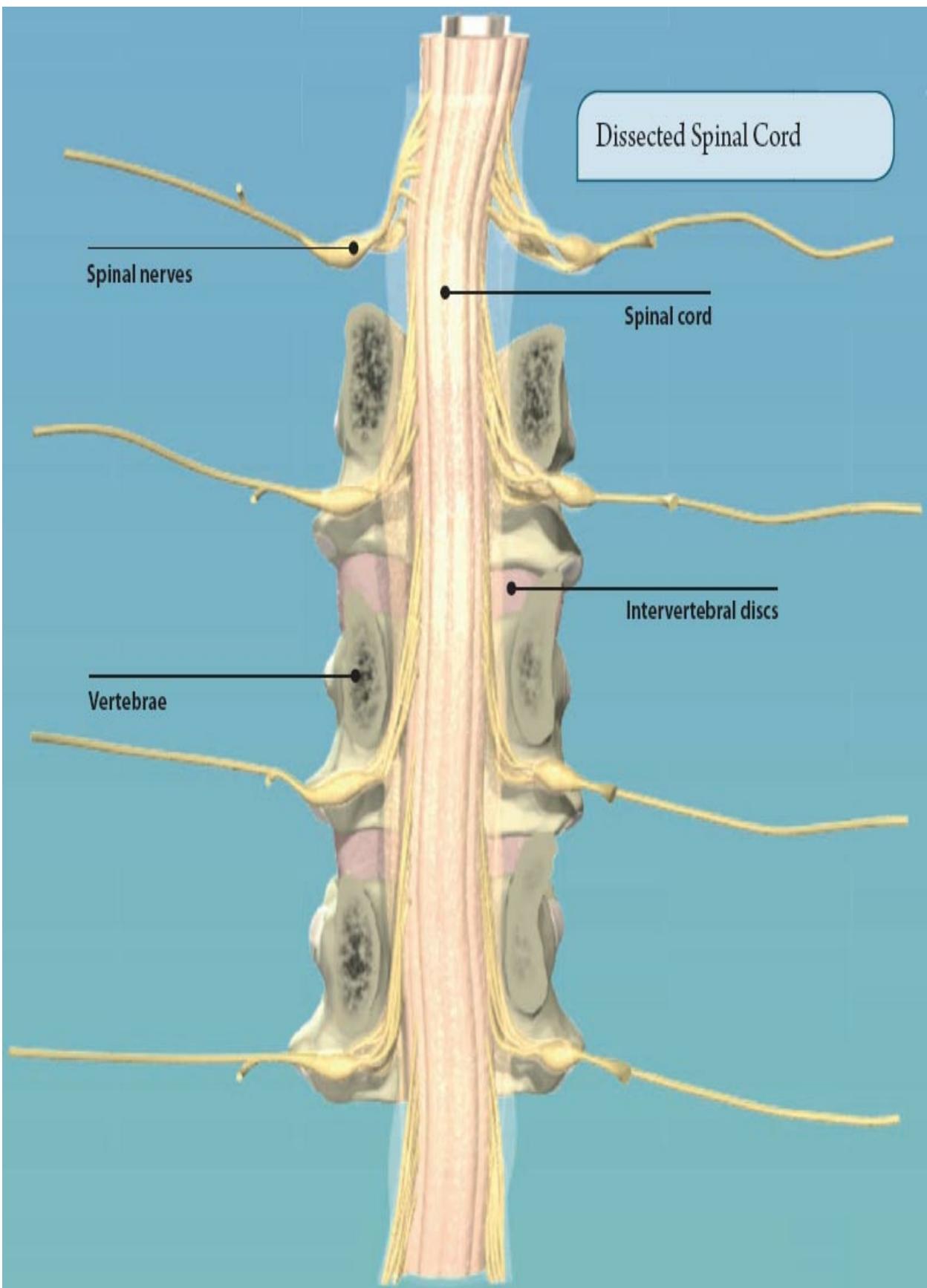
The spinal cord relays nerve signals between the brain and the rest of the body. It joins the brainstem as it enters the skull. The spinal cord runs inside the vertebral canal, and ends at the level of the second lumbar vertebra (L2). Below this level, the spinal nerves continue as a collection of fibers called the cauda equina.

There are thirty-one pairs of spinal nerves that supply the body. They exit the vertebral canal through gaps between the vertebrae. Like the brain, the spinal cord is covered by the meninges, and bathed in cerebrospinal fluid (CSF).

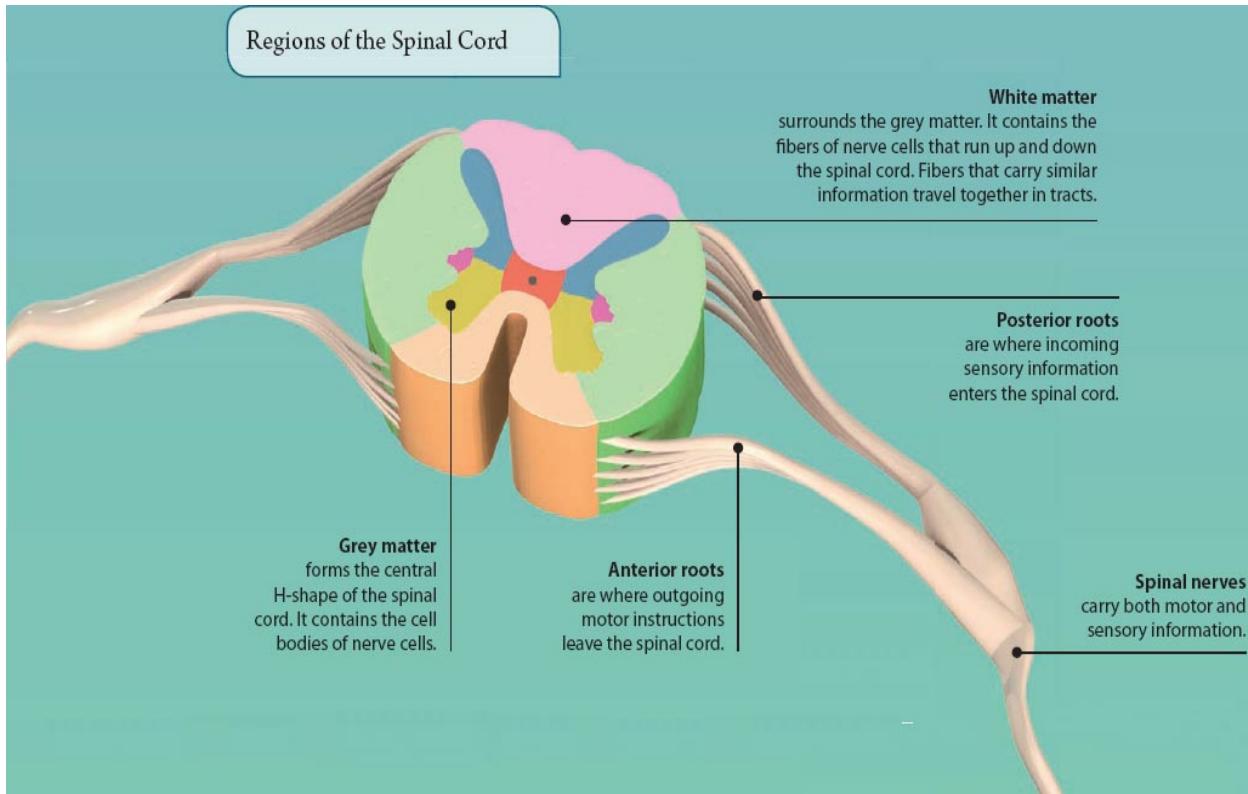
Did you know?

In diseases like meningitis, it is important for doctors to get samples of a patients' cerebrospinal fluid (CSF). This can be done by inserting a needle into the vertebral canal in a procedure called a lumbar puncture, or spinal tap. By inserting the needle well below the second lumbar vertebra (L2), this ensures that the spinal cord is not damaged by the needle.





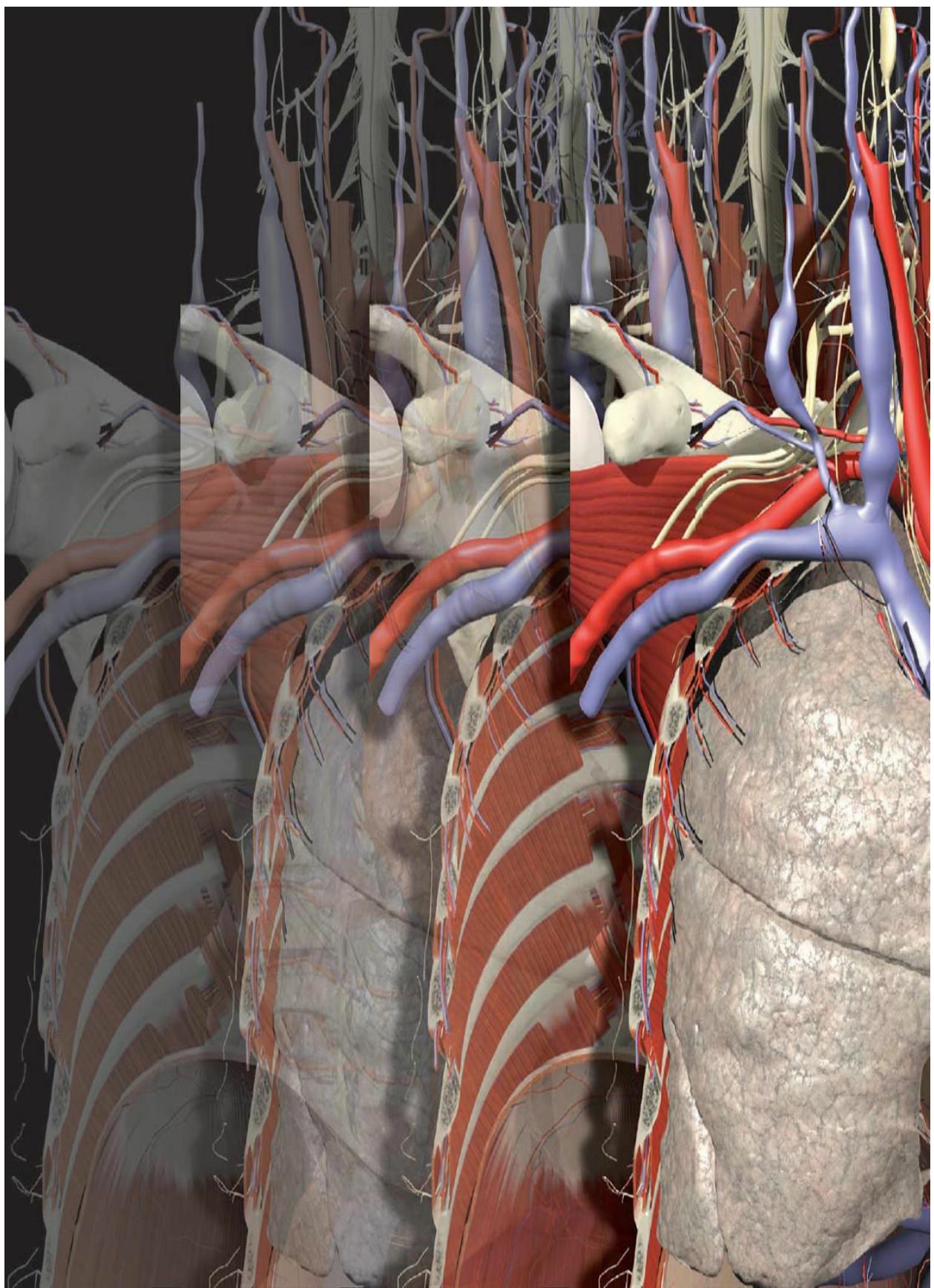
Regions of the Spinal Cord

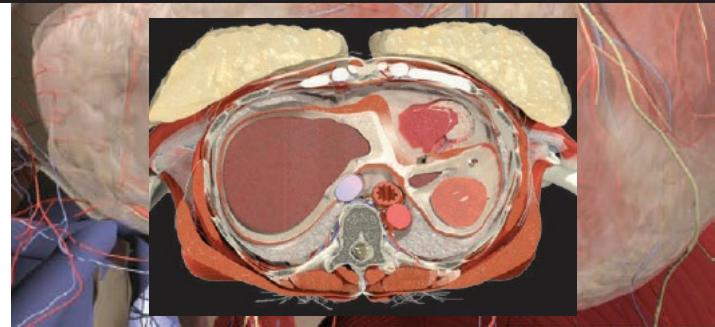
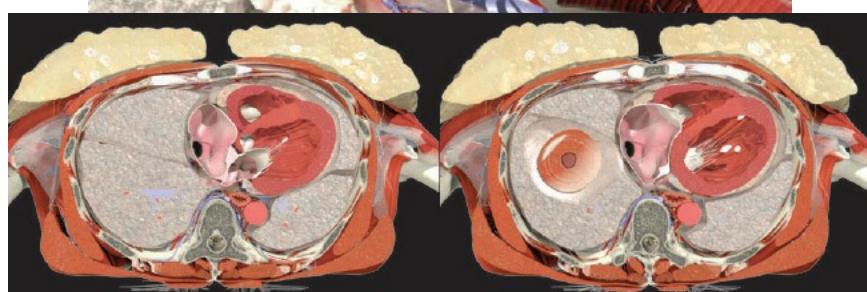
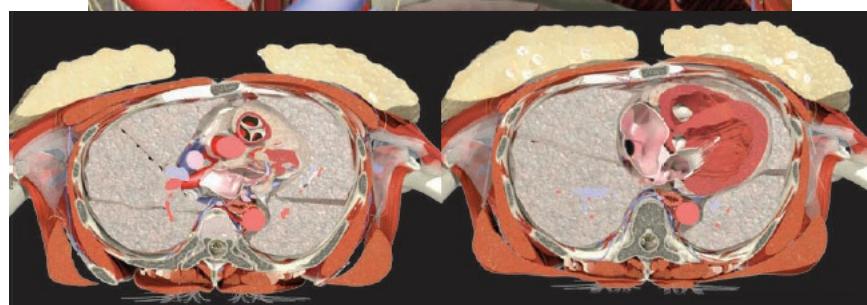
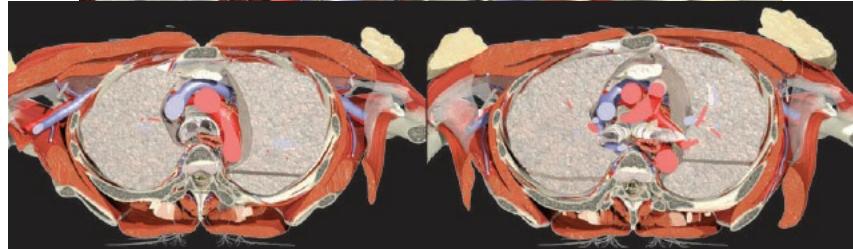


CHAPTER 4: THE THORAX

The upper part of the trunk is called the thorax, or chest. It lies between the neck and abdomen, and is mainly formed by the bony ribcage. This structure protects the contents of the thoracic cavity (the space inside the ribcage), as well as moving to allow us to breathe.

The thorax contains the heart, lungs, and large blood vessels, along with other structures moving between the neck above, and the abdomen below. The thoracic cavity is separated from the abdominal cavity by the muscular diaphragm. Numerous muscles that assist with breathing and movements of the arms and trunk are attached to the rib cage. The breasts are found at the front of the thorax.



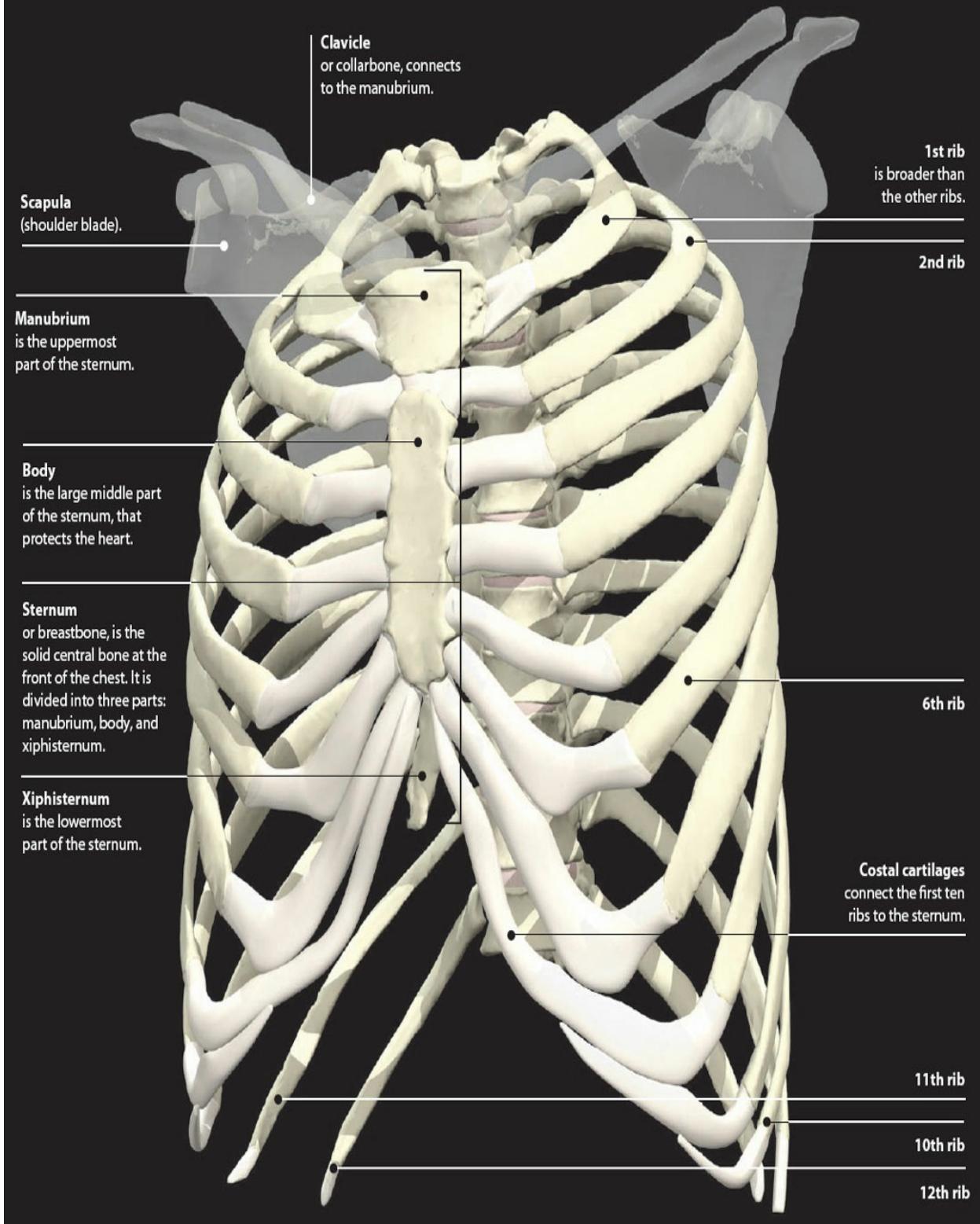


BONES OF THE THORAX

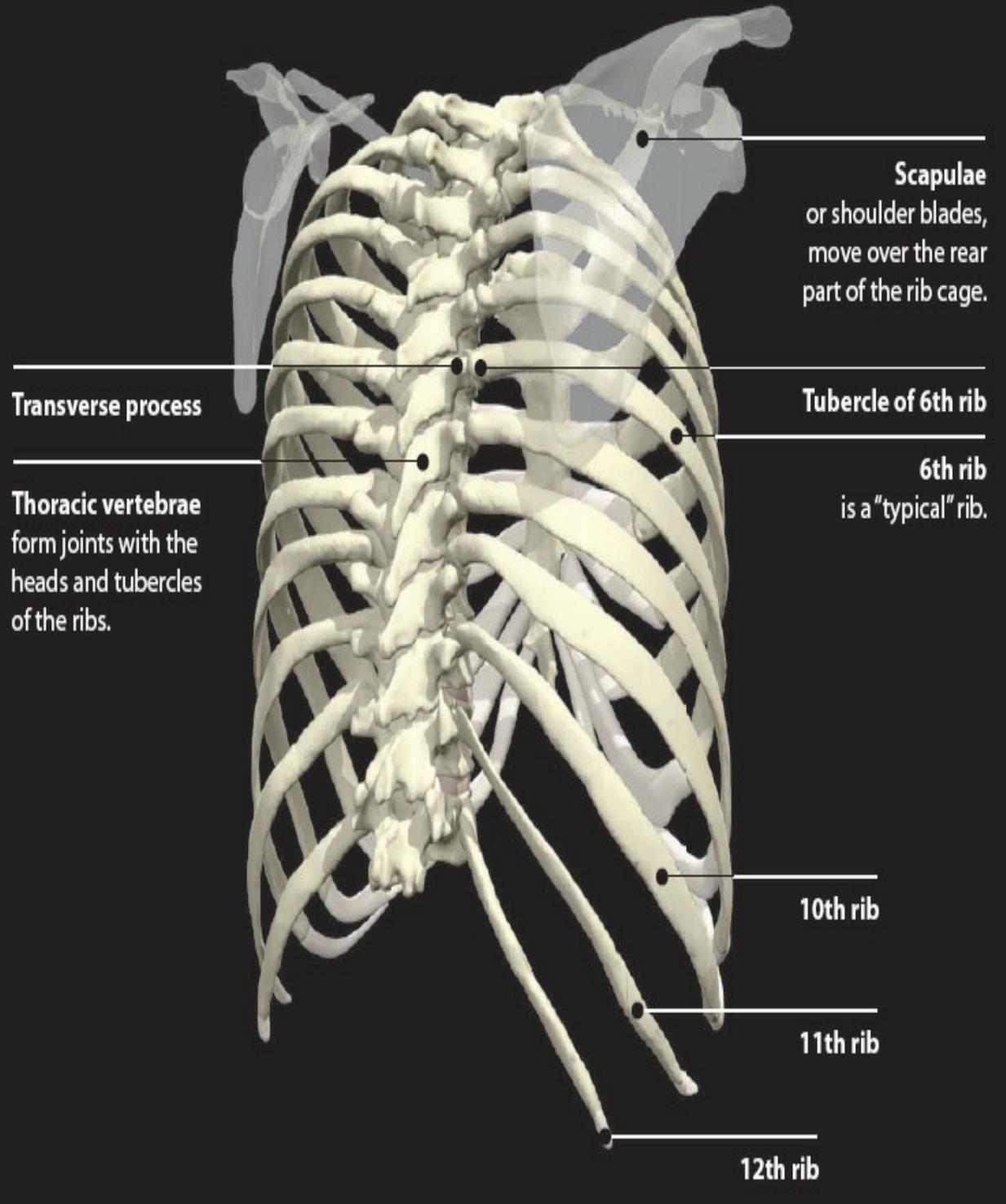
The ribs, sternum, and thoracic vertebrae form the bony framework of the thorax, the thoracic cage. There are twelve pairs of ribs. They form joints at the back with the thoracic vertebrae. At the front, most are connected to the sternum by flexible costal cartilages.

The rib cage is mobile, with the ribs able to move up and down. This movement expands the thoracic cavity and allows us to breathe. A typical rib has a head, neck, tubercle, and body.

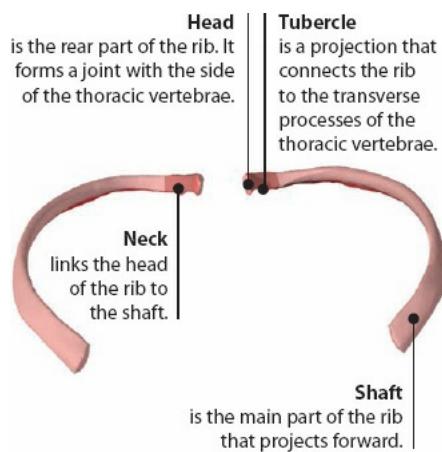
Throatic Cage Anterior View



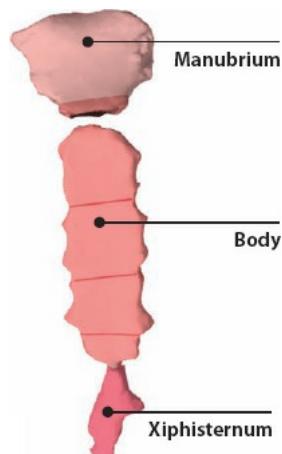
Throatic Cage Posterior View



Ribs and Sternum



Rib 6

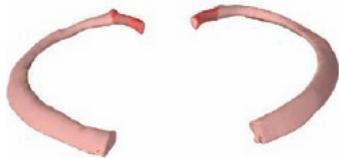


Sternum, manubrium, and xipisternum

Ribs



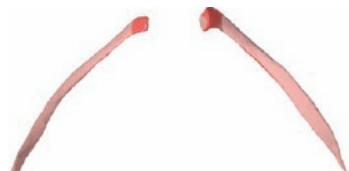
Rib 1



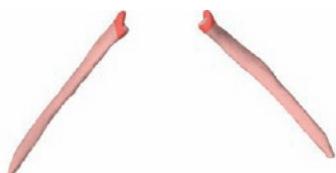
Rib 2



Rib 10



Rib 11



Rib 12

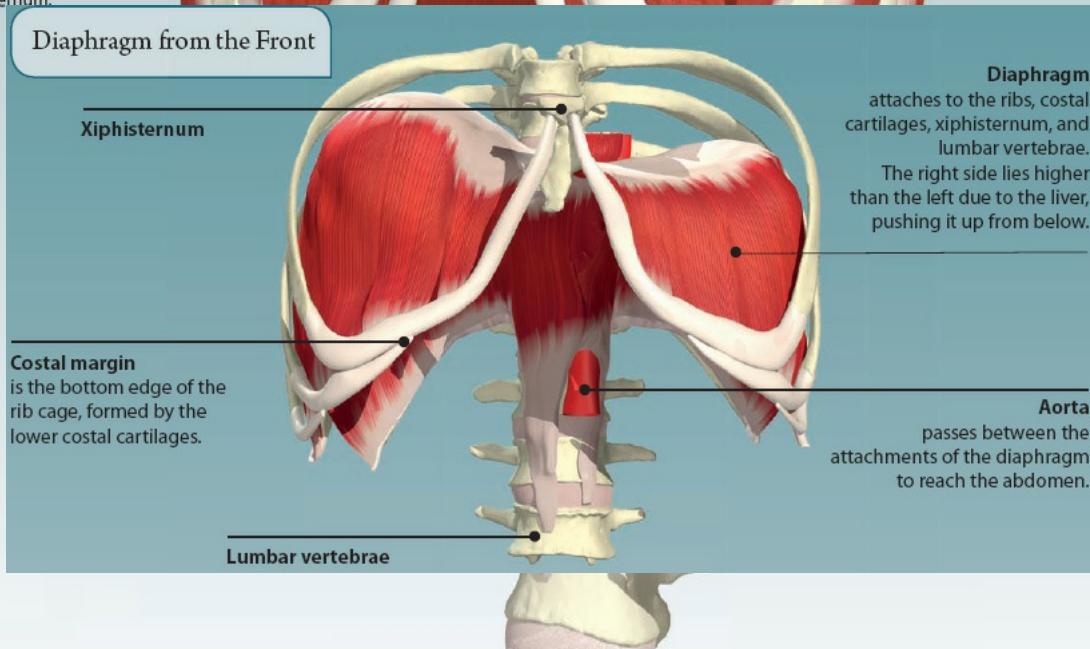
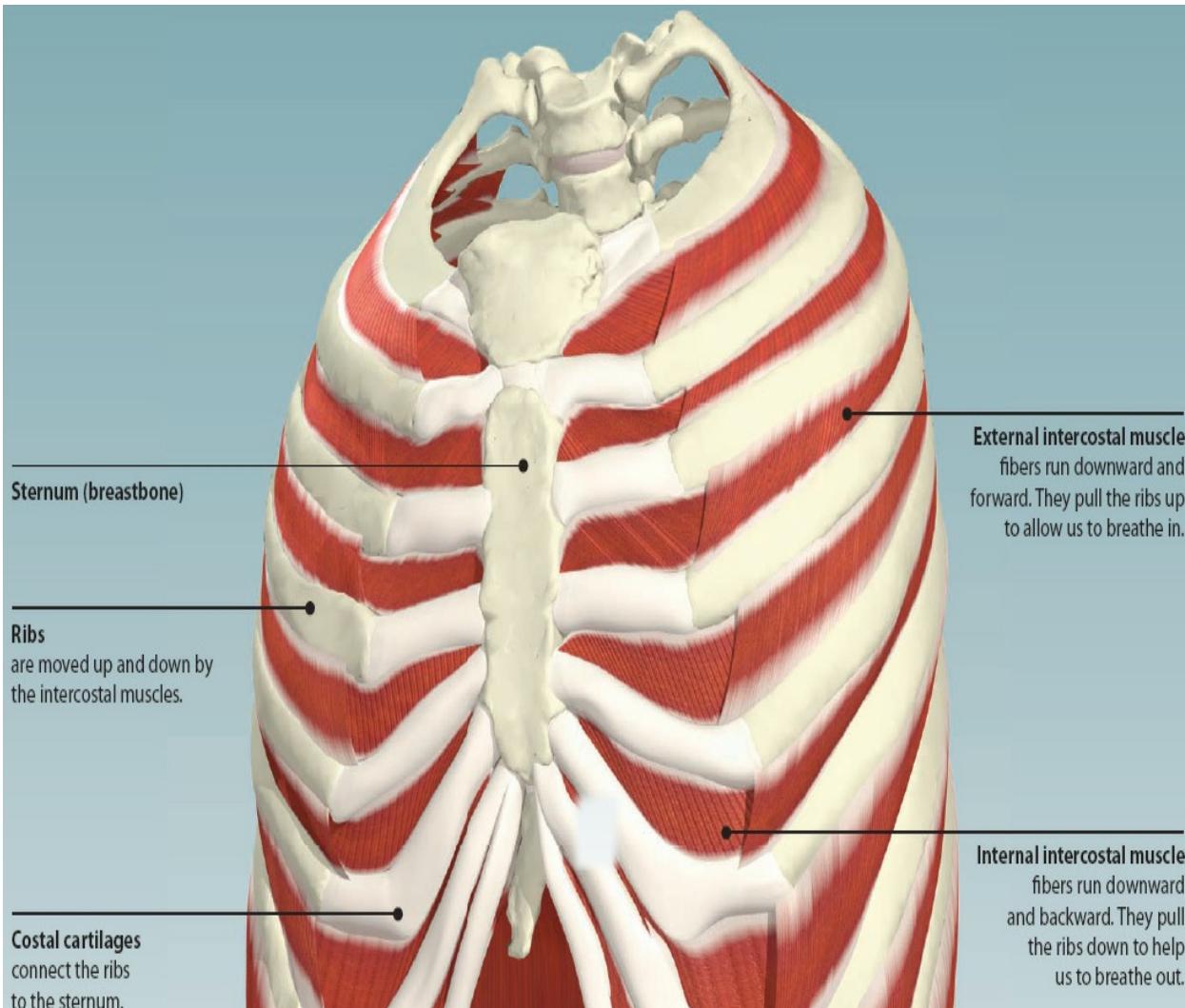
MUSCLES OF THE THORAX

The main muscles of the thorax are the diaphragm and intercostal muscles. They are called muscles of respiration, as their main role is to help us breathe.

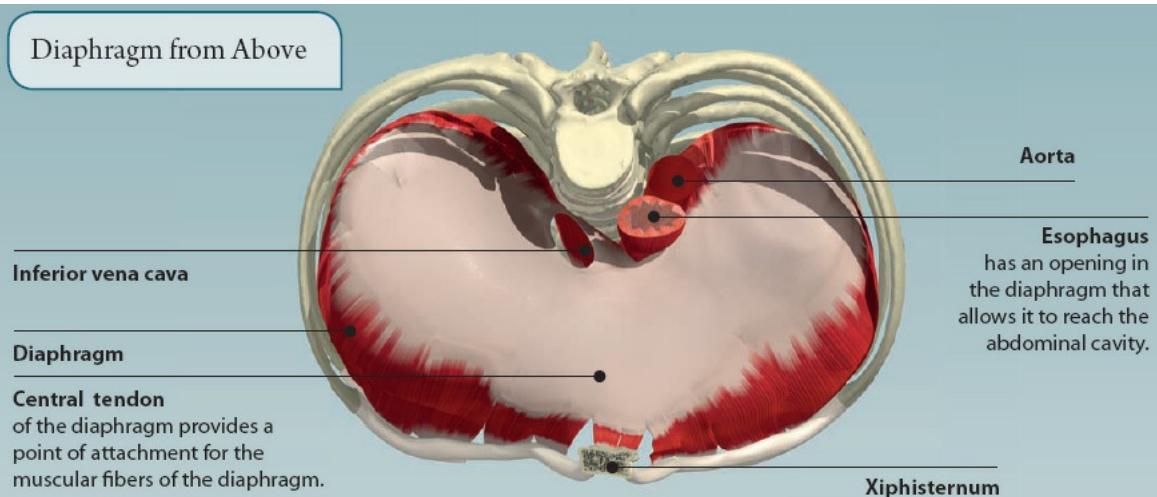
The intercostal muscles lie between the ribs, and move the rib cage up and down.

The diaphragm is a large dome-shaped sheet of muscle that separates the thoracic and abdominal cavities. When it contracts, it flattens and moves downward. This increases the size of the thoracic cavity and helps us to breathe in.

Other muscles that lie on the surface of the rib cage can help when we need to breathe hard and fast, for example, during exercise.



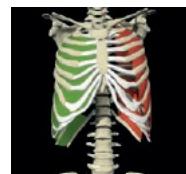
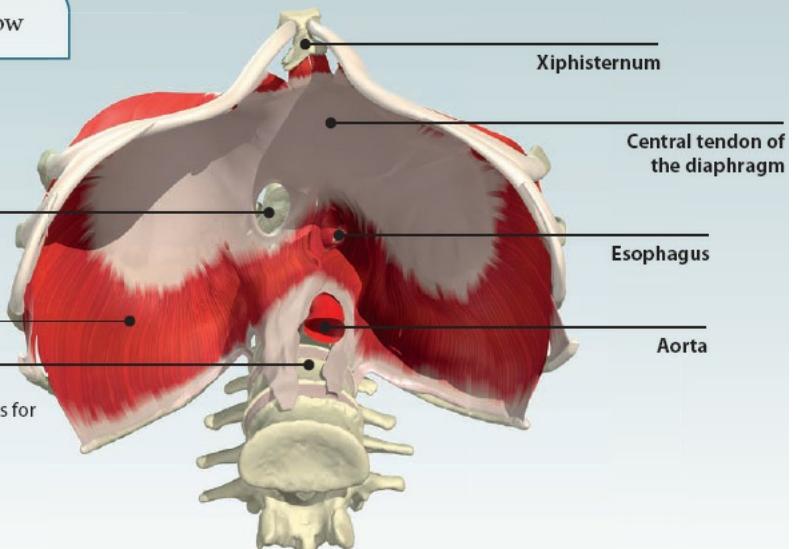
Diaphragm from Above



Diaphragm from Below

Inferior vena cava
drains blood from the lower part of the body. It passes through the diaphragm to reach the heart.

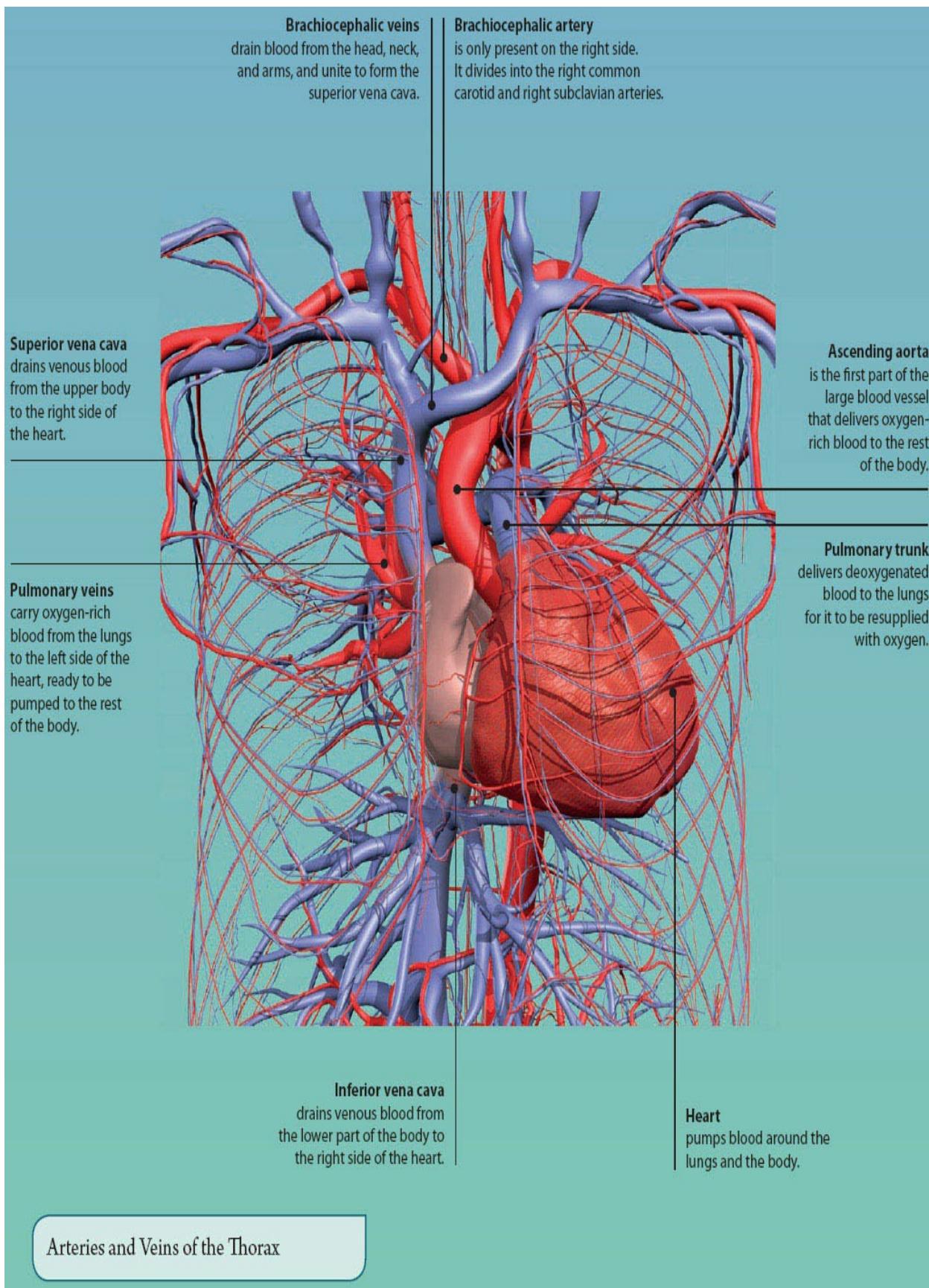
Diaphragm
Lumbar vertebrae
provide attachments for the diaphragm.





NEUROVASCULAR STRUCTURES OF THE THORAX

The thorax contains the large blood vessels that enter and leave the heart, along with numerous other branches. Twelve pairs of thoracic spinal nerves innervate the skin of the thorax and intercostal muscles.



Arteries and Veins of the Thorax

Thoracic Aorta

Arch of the aorta
is the second and highest part of the aorta. It gives off the brachiocephalic, left common carotid, and left subclavian arteries.

Ascending aorta

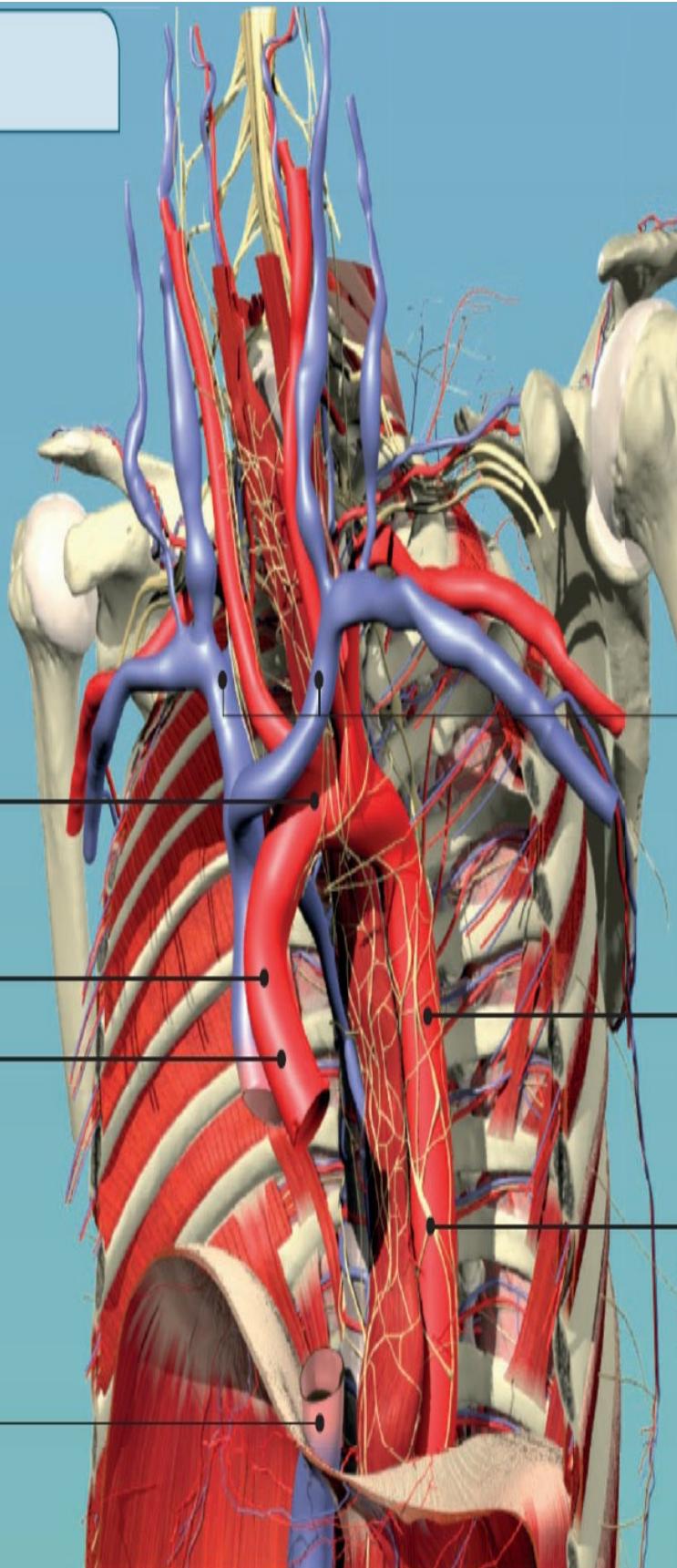
Superior vena cava

Inferior vena cava

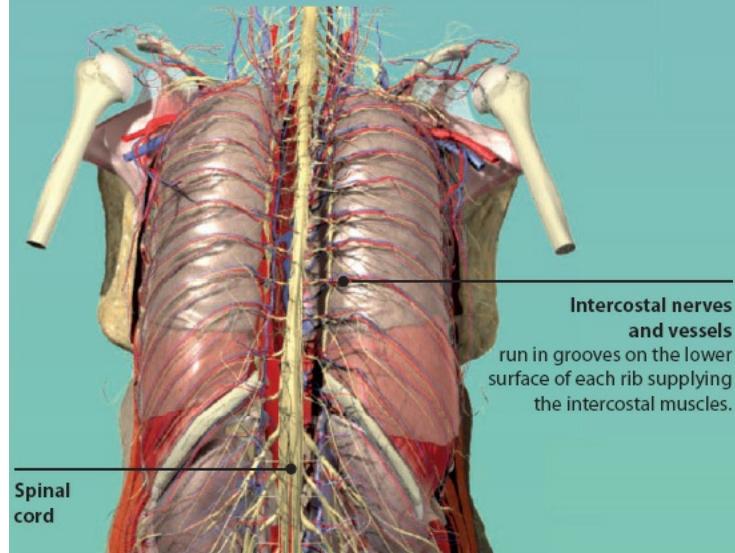
Brachiocephalic veins

Thoracic (descending) aorta
travels down the thorax and through the diaphragm.

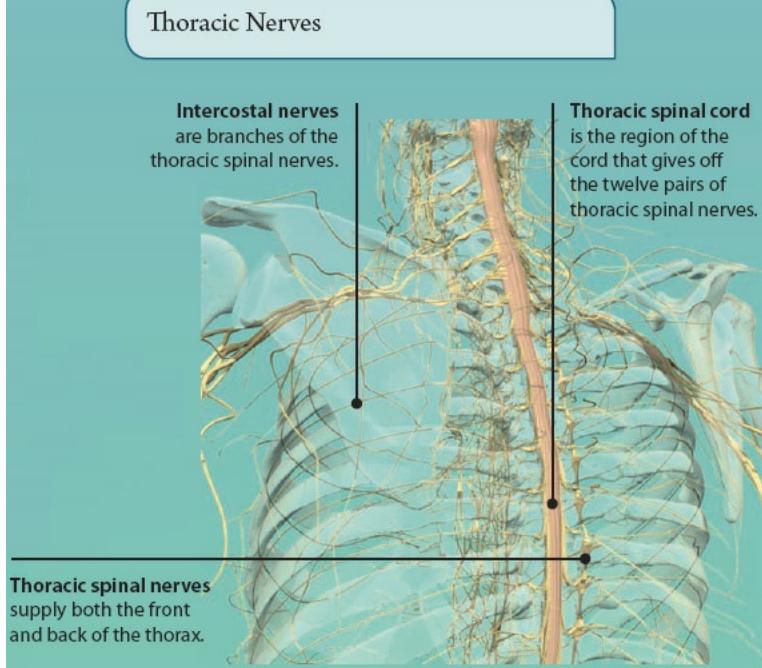
Esophageal and aortic plexuses
are collections of nerves that help control the gastrointestinal tract.



Dissected Thoracic Spinal Cord in situ



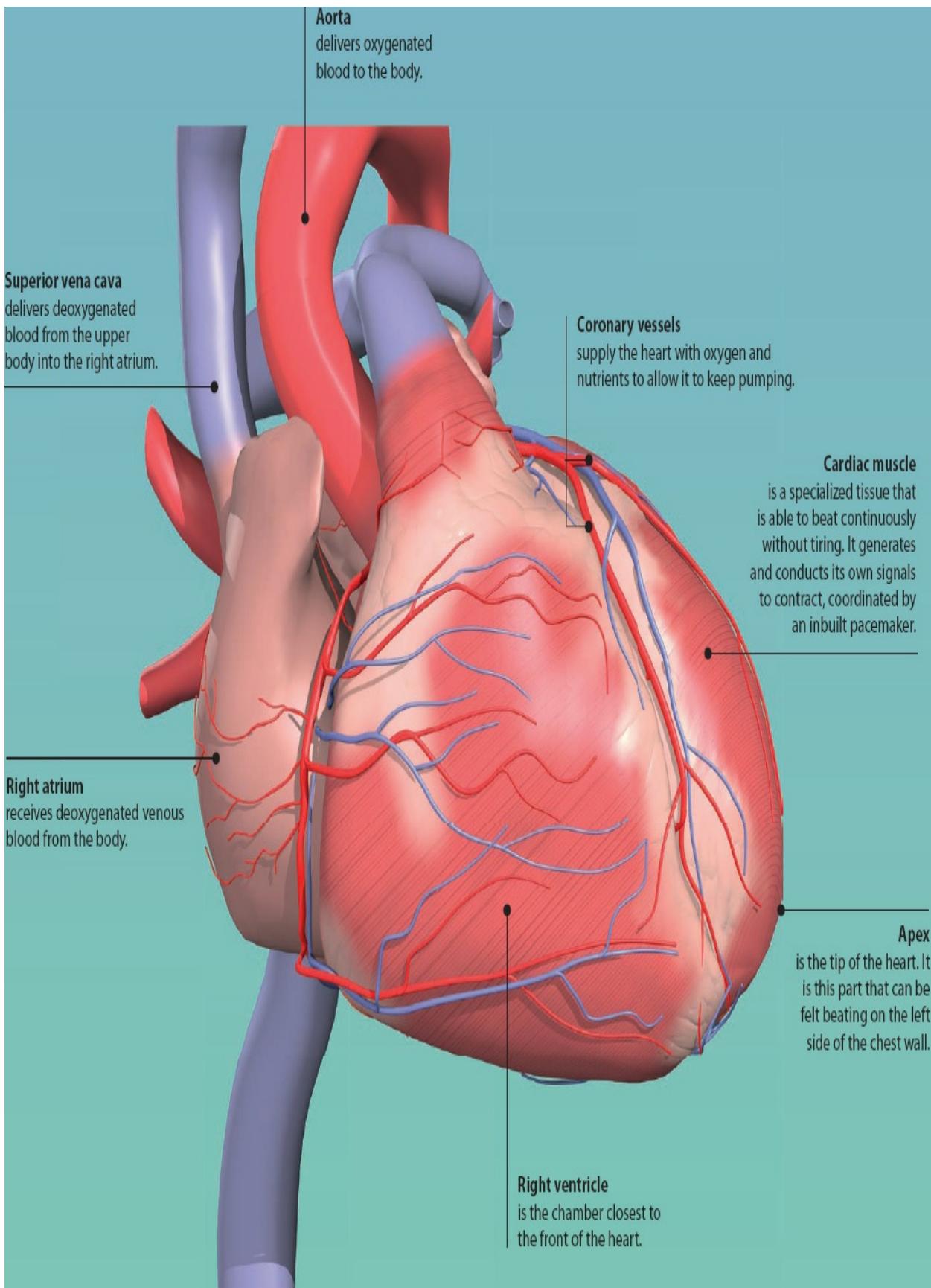
Thoracic Nerves

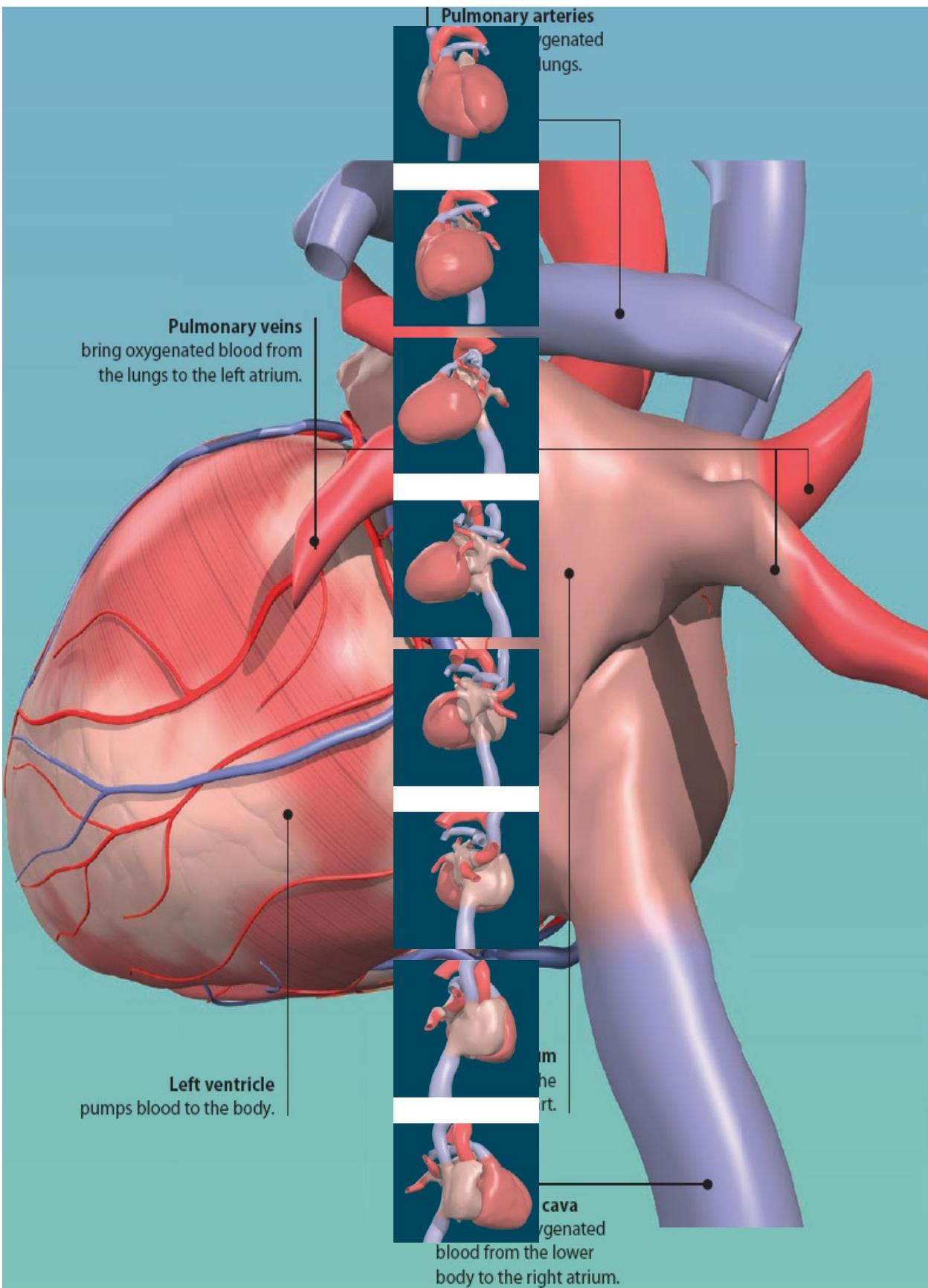


THE HEART

The heart is a fist-sized, muscular organ. It is located in the chest between the lungs, and is tilted to the left side. It continuously pumps blood around the lungs and body. This provides the cells and tissues of the body with the oxygen and nutrients they need to stay alive.

The heart is divided into right and left sides, which pump blood around different circuits. The right side of the heart receives deoxygenated blood from the body and pumps this to the lungs. The left side of the heart receives oxygenated blood from the lungs and pumps this to the rest of the body. Each side of the heart has two chambers: an atrium (priming chamber) and a ventricle (pumping chamber).





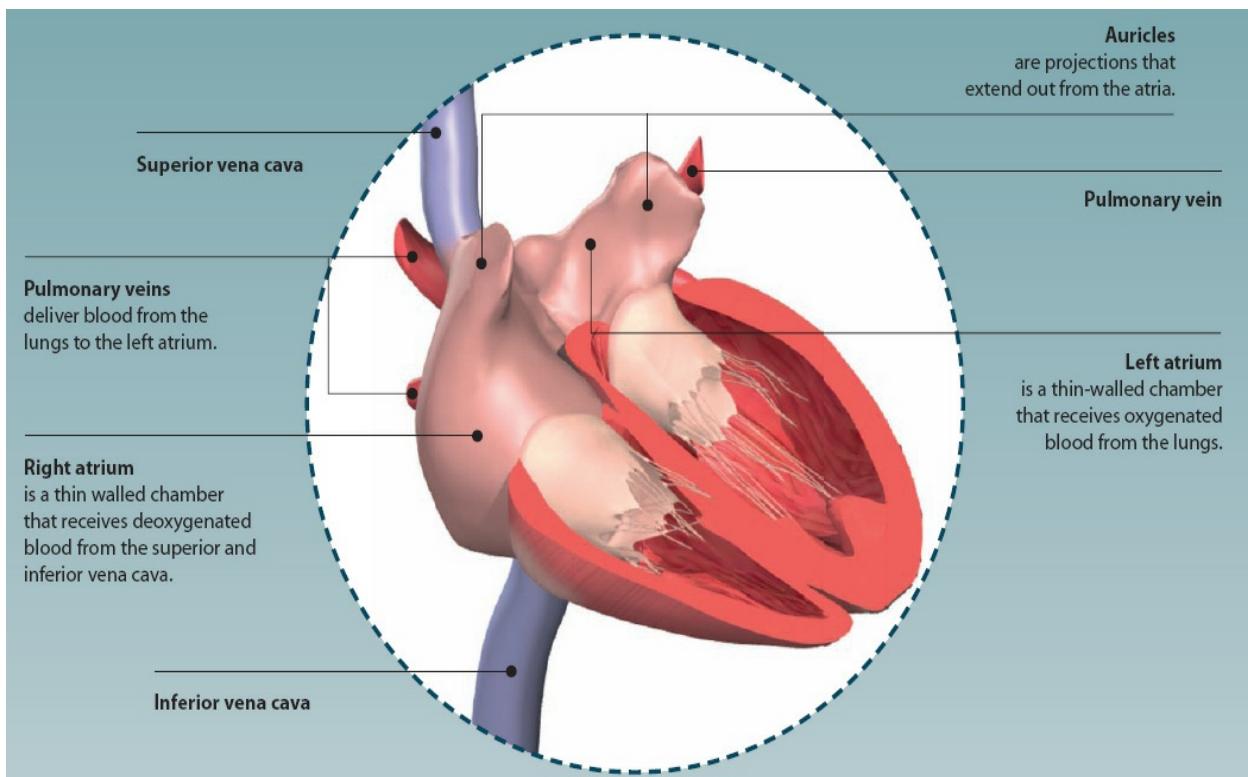
CHAMBERS OF THE HEART

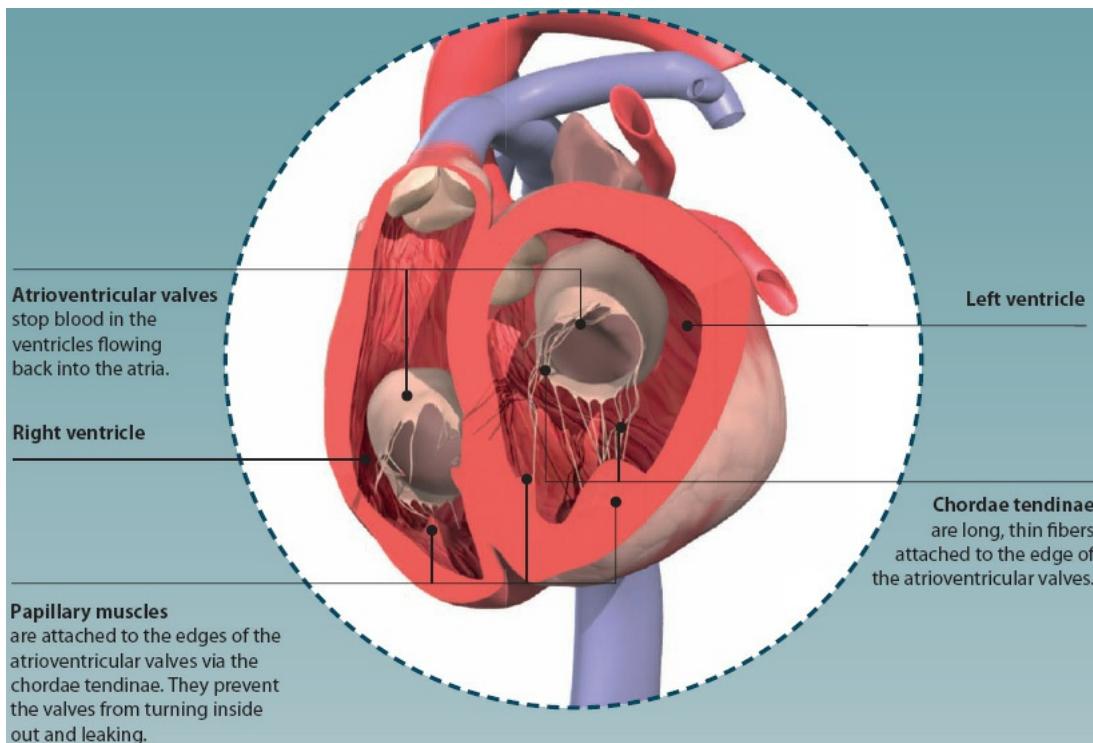
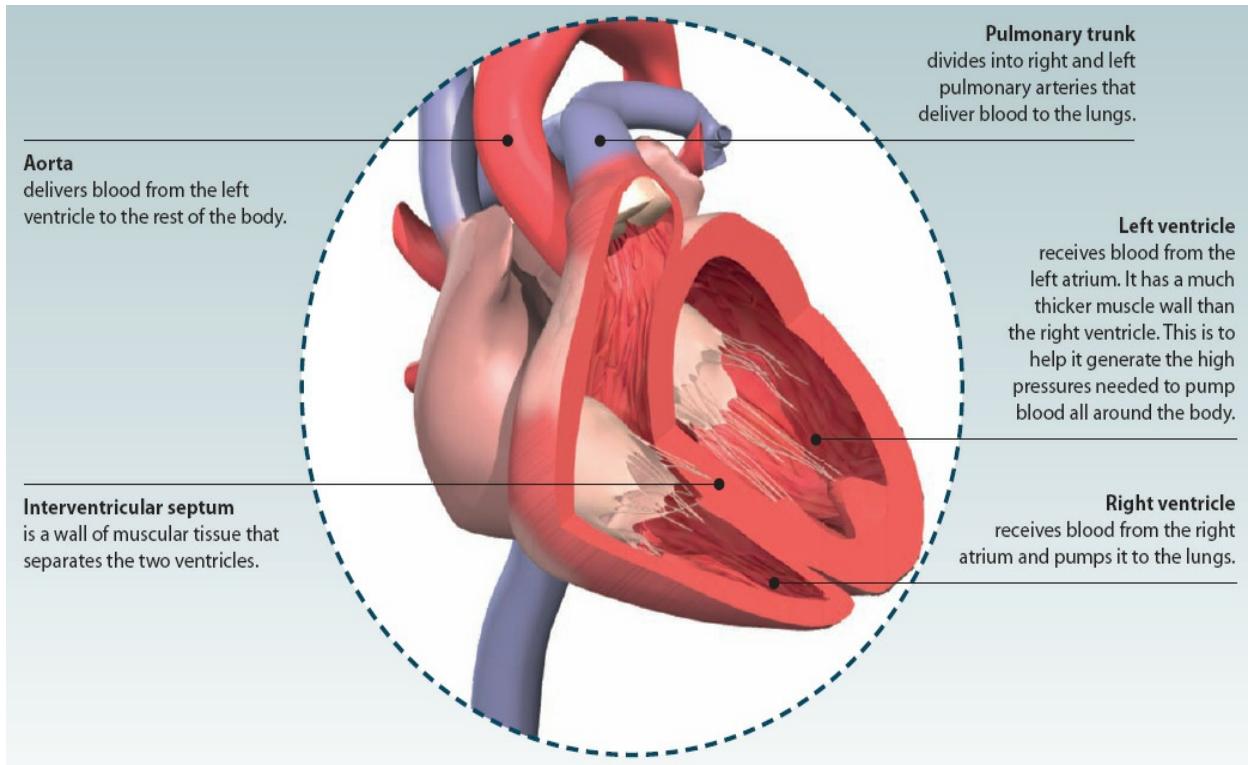
The heart has four chambers (two atria and two ventricles) in which blood is collected and pumped. The chambers of the right and left side of the heart are separated by a fibromuscular wall called the septum.

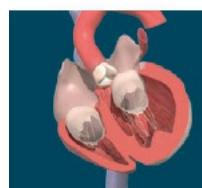
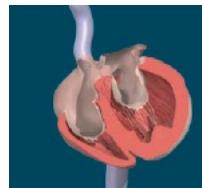
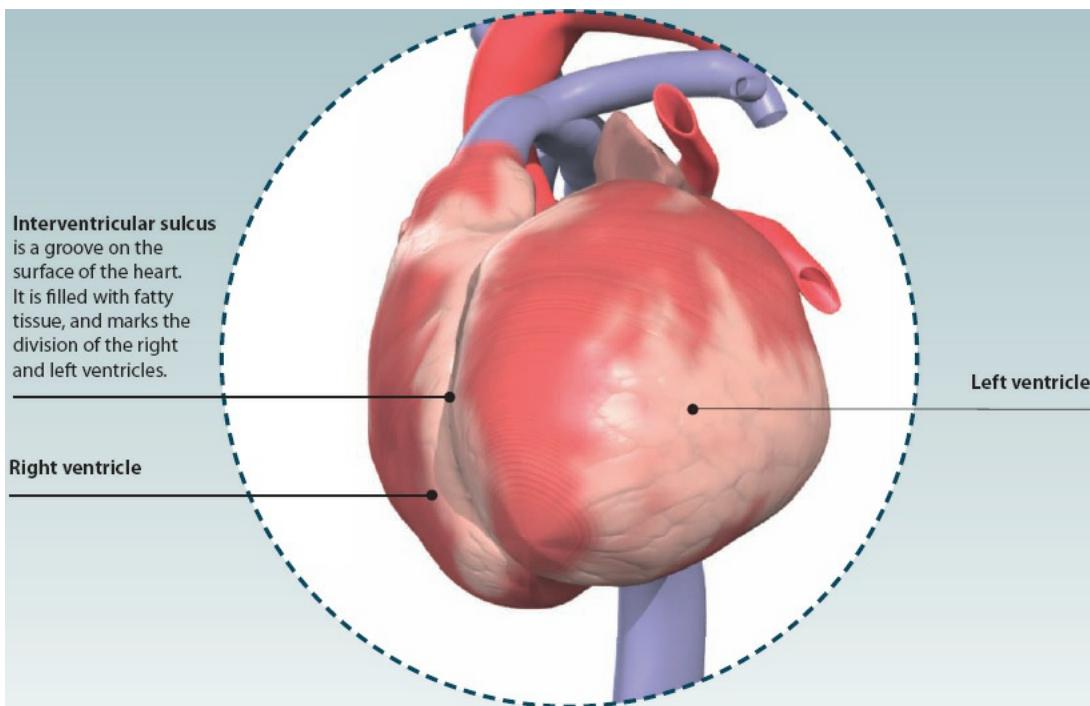
Atrioventricular valves lie between the atria and ventricles on each side. These ensure that blood only flows in one direction through the heart.

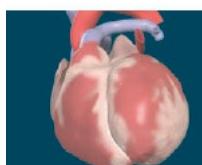
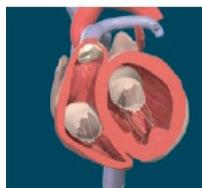
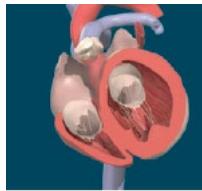
Did you know?

On average, the human heart beats about 100, 000 times a day; that's approximately 35 million times every year without a rest!







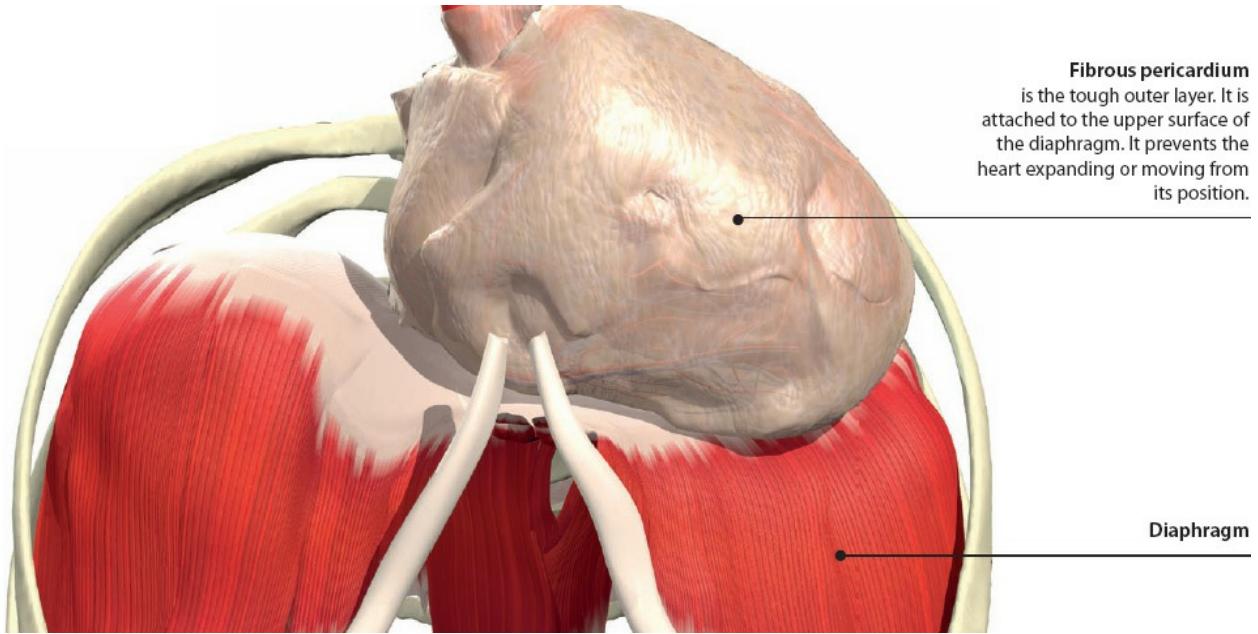


POSITION OF THE HEART

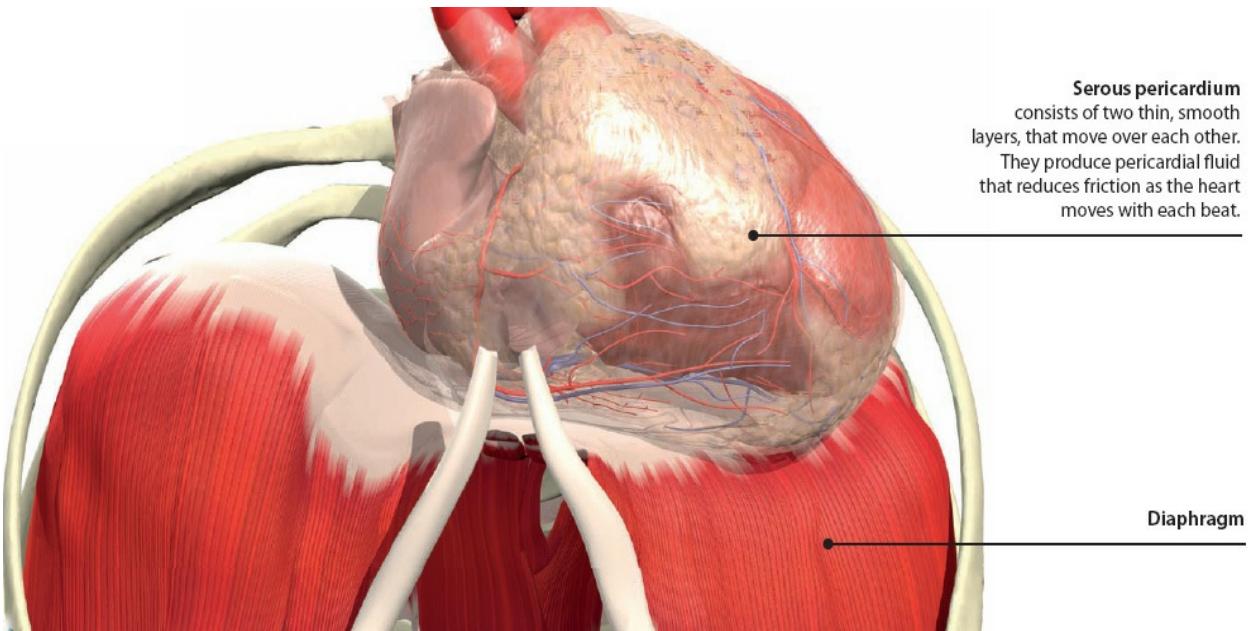
The heart is found within the thorax between the two lungs. It sits on top of the diaphragm, behind the sternum (breastbone) and ribs. It is shaped like a cone, with an apex that points to the front and left, and a base pointing backwards and to the right.

The heart is surrounded and contained by a sac called the pericardium. This has a smooth inner serous layer, and a tough outer fibrous layer.

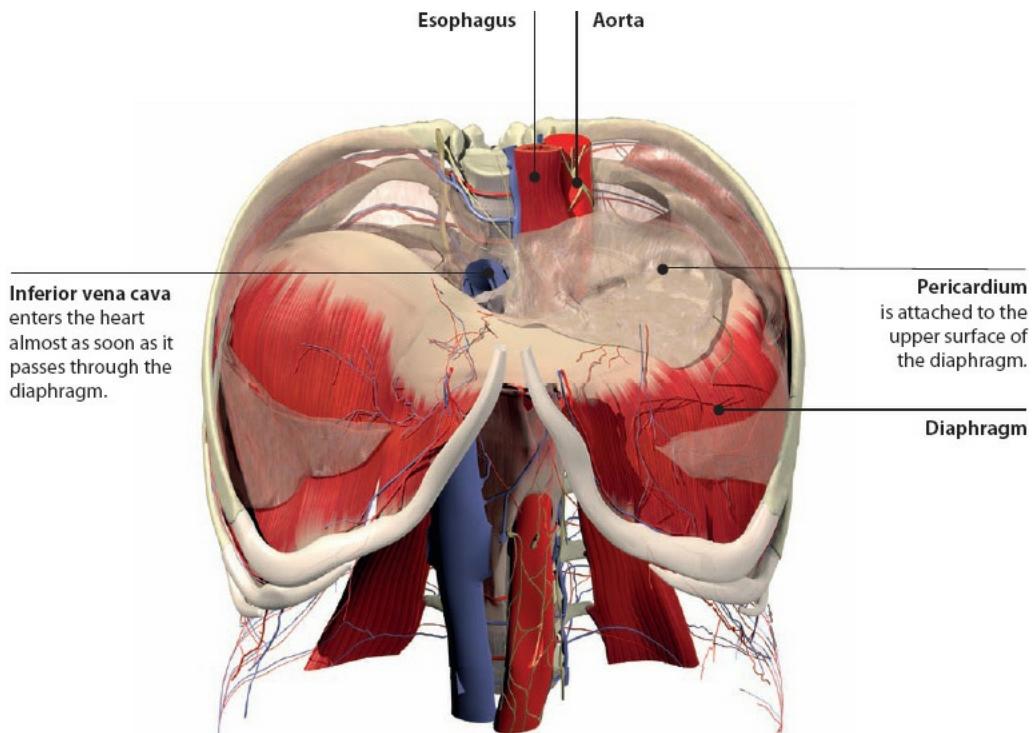
Outer Layer of Pericardium



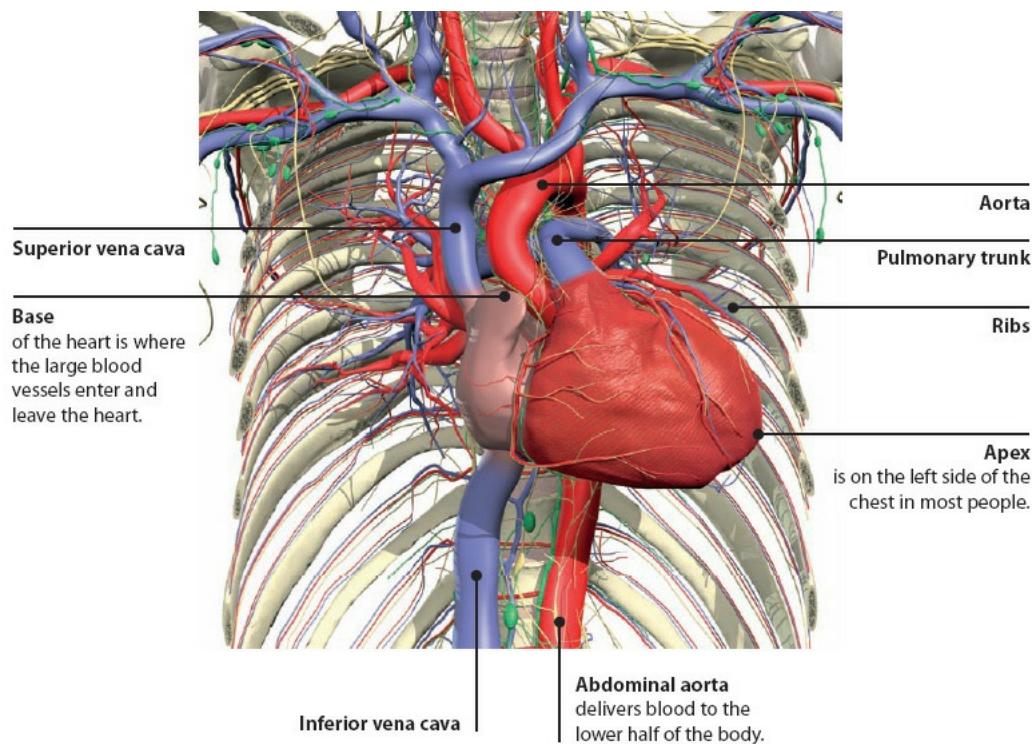
Inner Layer of Pericardium

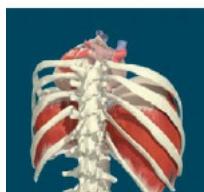
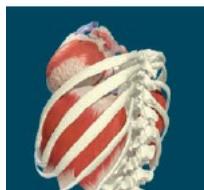


Position of Pericardium



Heart Within the Thorax



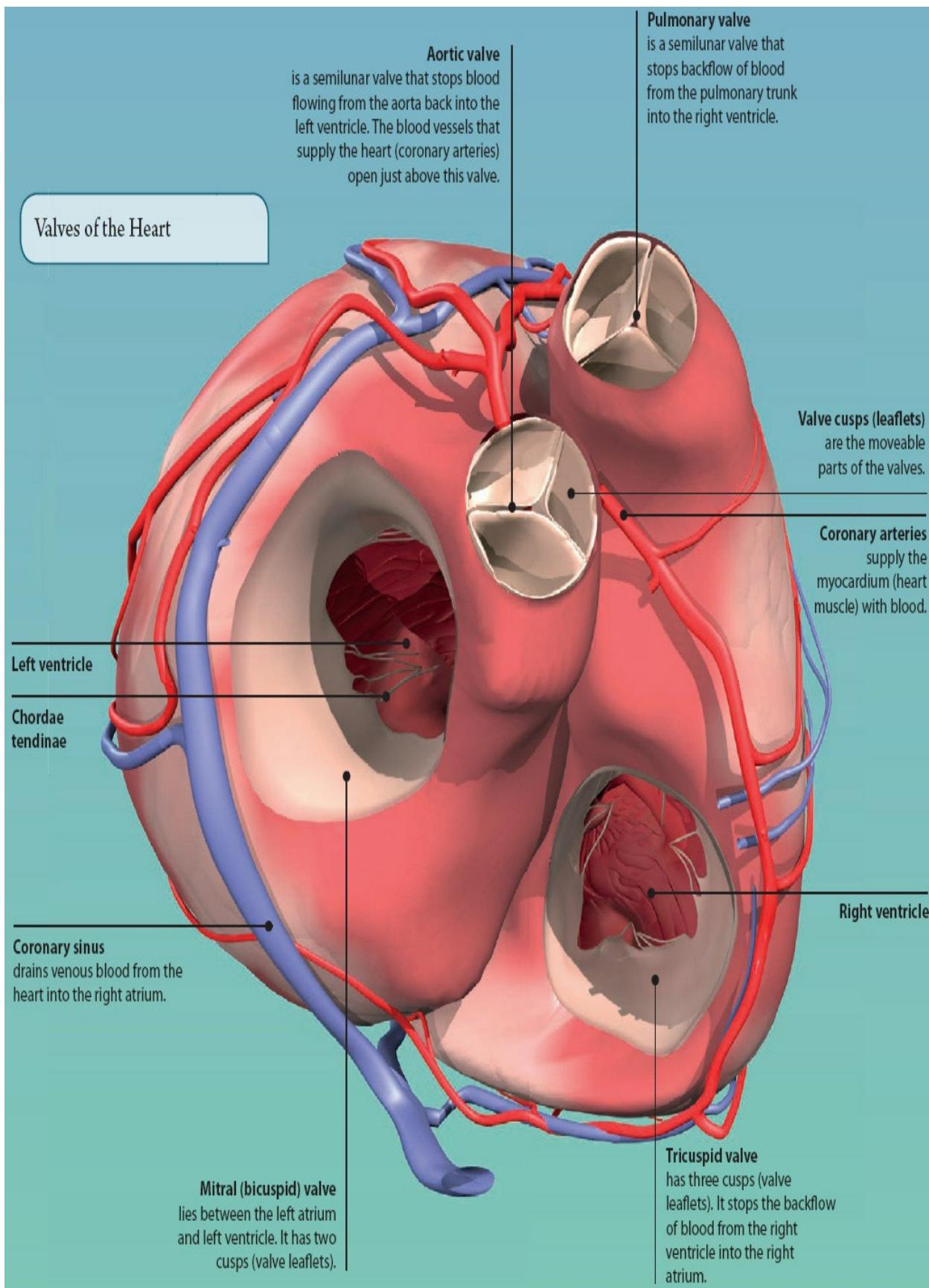


VALVES OF THE HEART

The heart has four valves. Their function is to allow blood to flow in only one direction through the chambers of the heart. They open and close in response to pressure changes within the chambers of the heart.

The atrioventricular valves lie between the atria and ventricles. The semilunar valves lie between the ventricles and large blood vessels carrying blood away from the heart. The valves are attached to the fibrous tissue that forms the framework of the heart.

It is the closing of the atrioventricular and semilunar heart valves that is heard through a stethoscope as the heart sounds “LUB” and “DUB.”

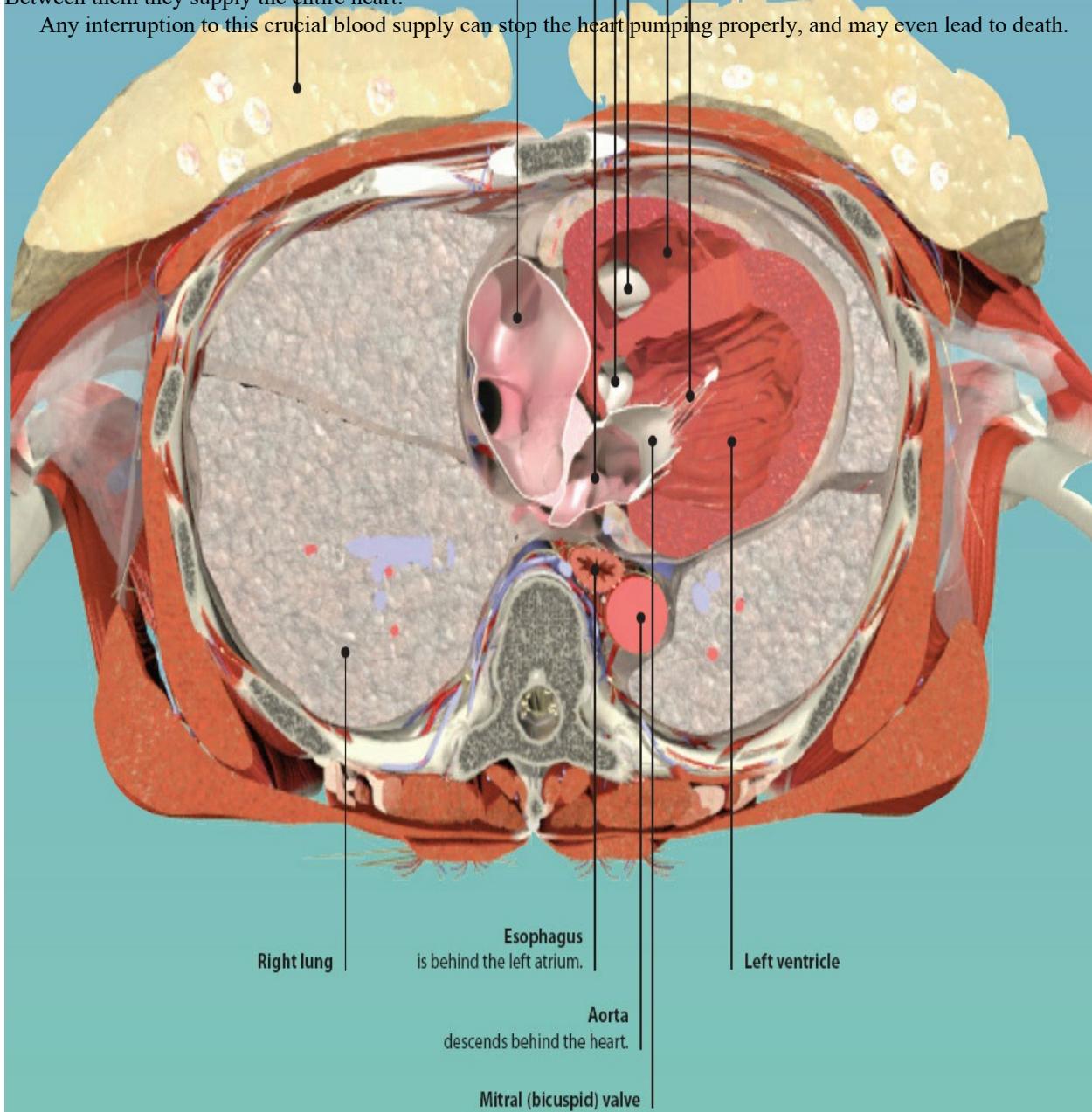


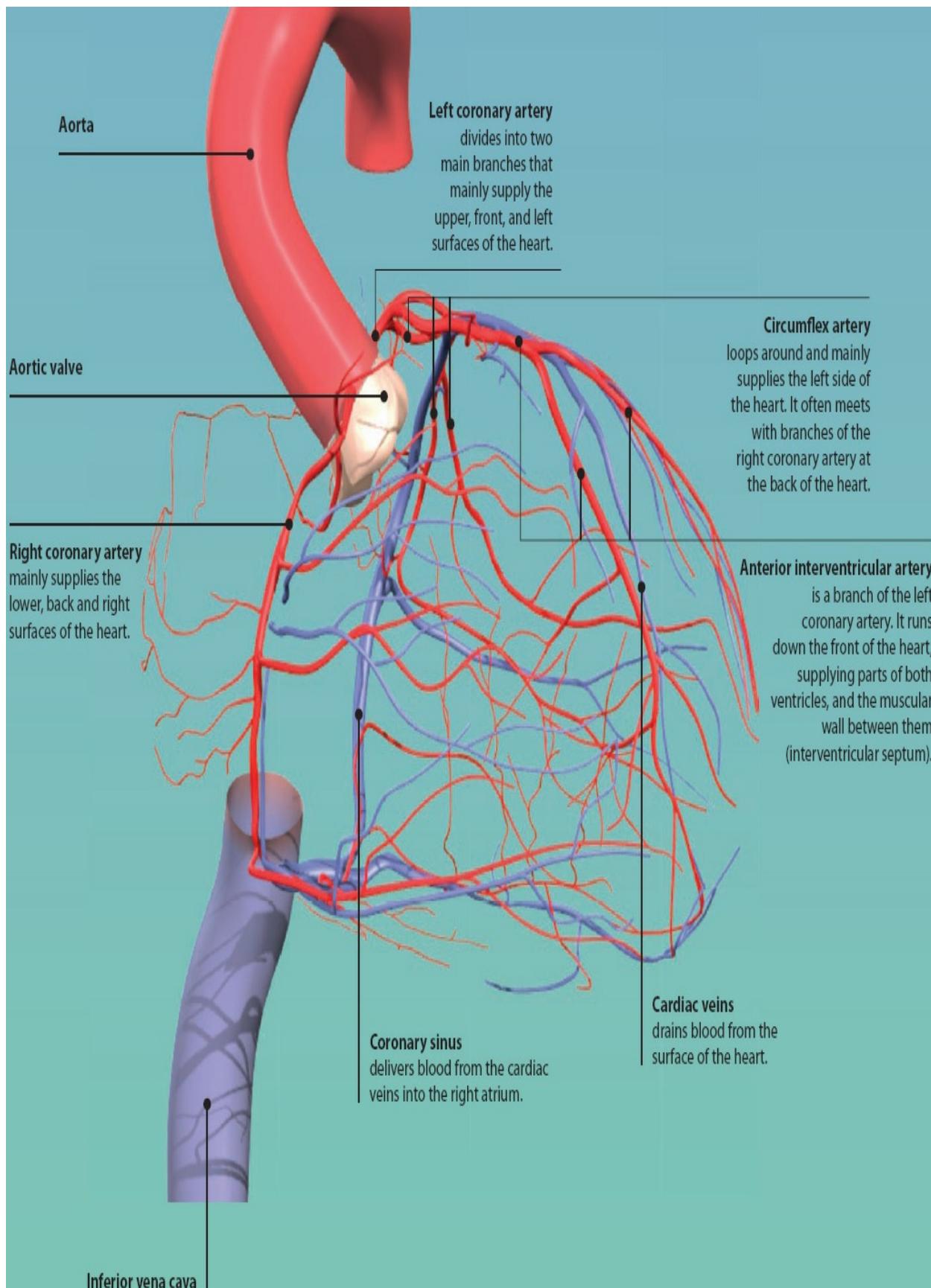
Cross Section Through the Heart

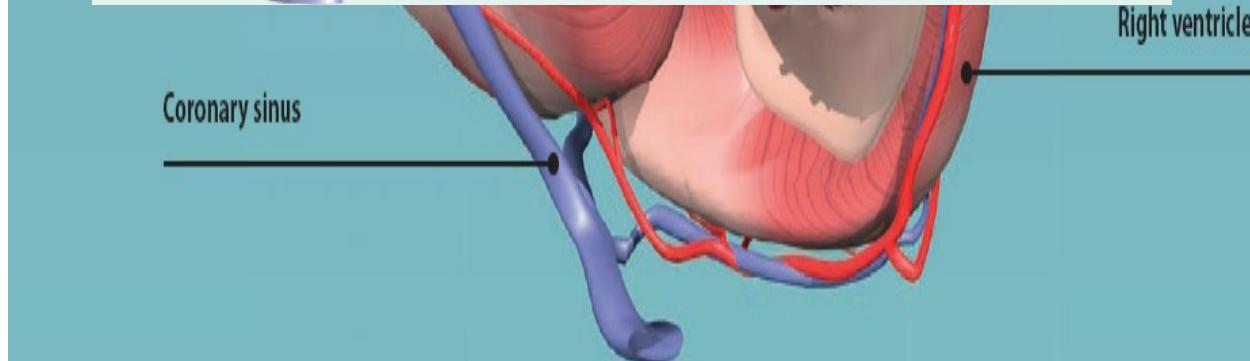
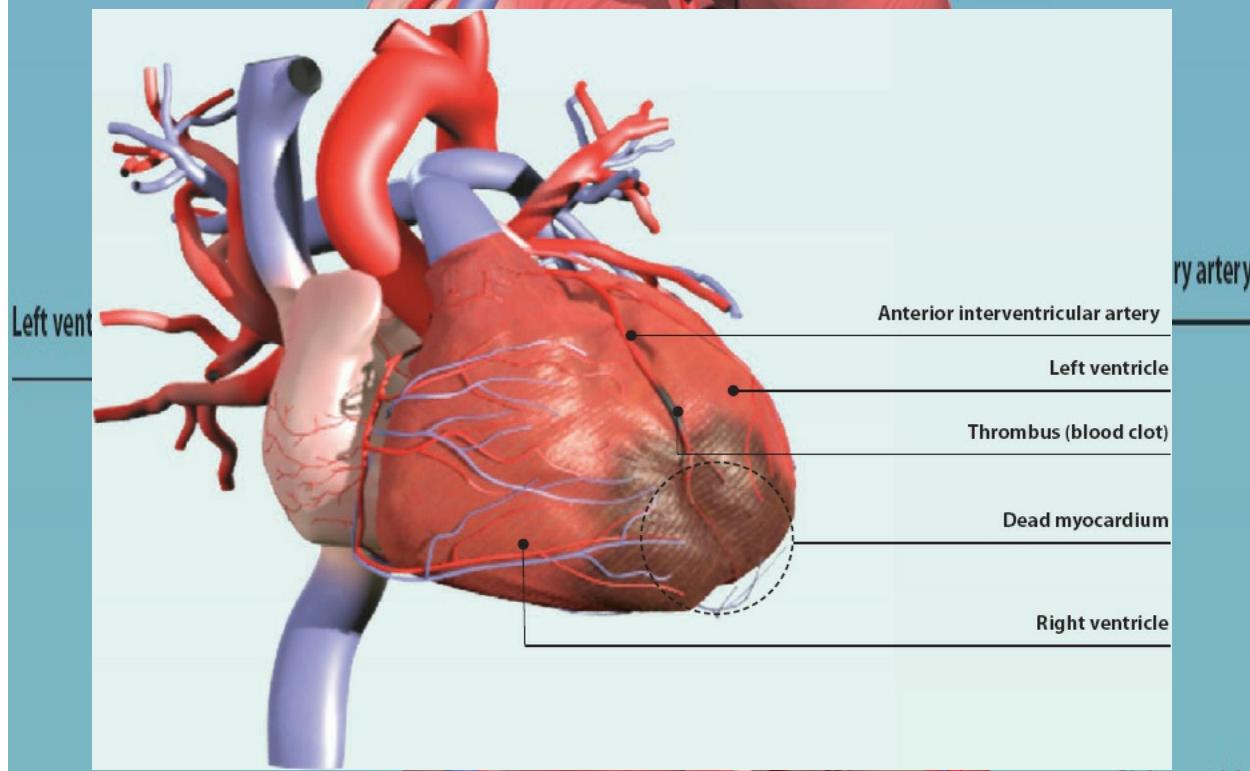
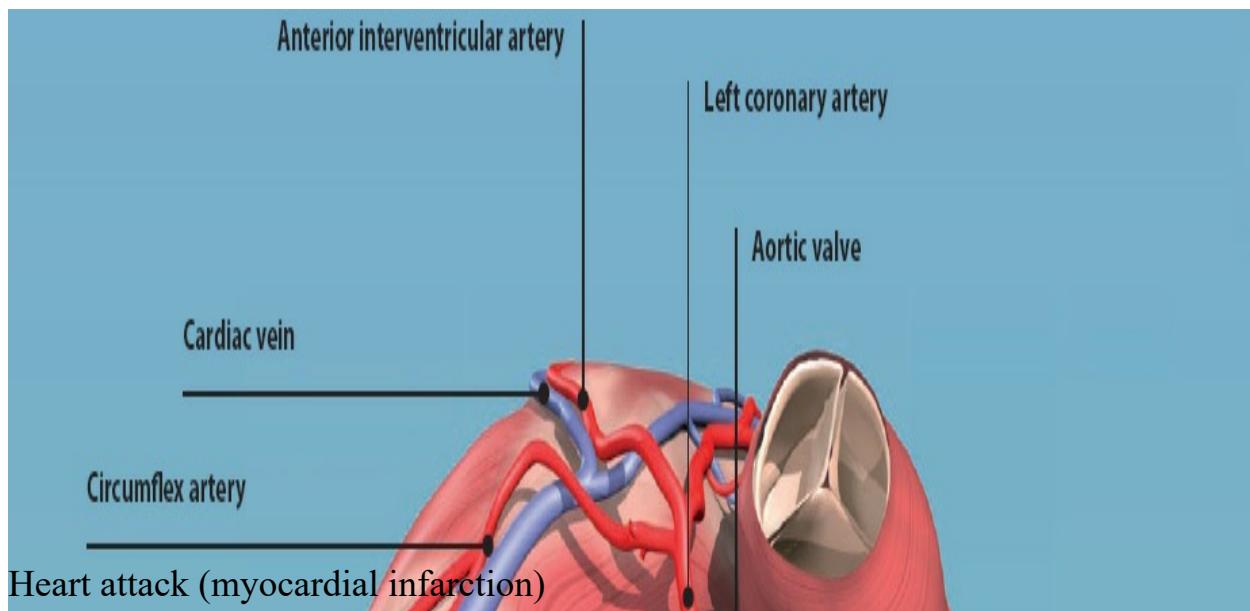
CORONARY CIRCULATION

The myocardium (heart muscle) needs a **constant supply** of oxygen- and nutrient-rich blood to keep it pumping. This is delivered by the right and left coronary arteries. They branch off the aorta **immediately after the aortic valve**. Between them they supply the entire heart.

Any interruption to this crucial blood supply can stop the heart pumping properly, and may even lead to death.





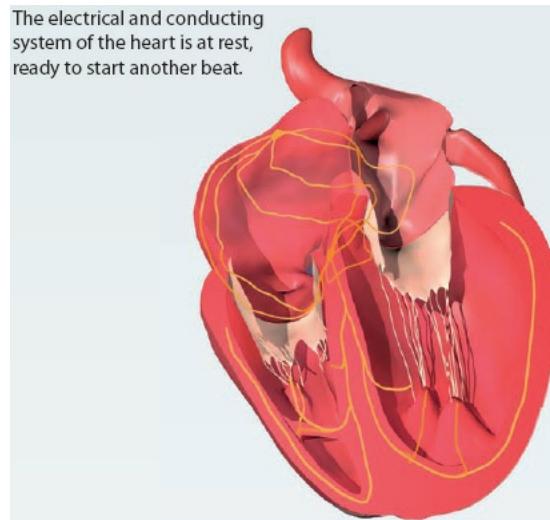


If a clot (thrombus) forms inside a coronary artery, it blocks the supply of blood to the myocardium “downstream” of it. If this blockage is prolonged, then the myocardium will die. This is referred to as a myocardial infarct, or heart attack. The dead myocardium means that the heart cannot pump as effectively. This may lead to death if the heart cannot pump blood around the rest of the body.

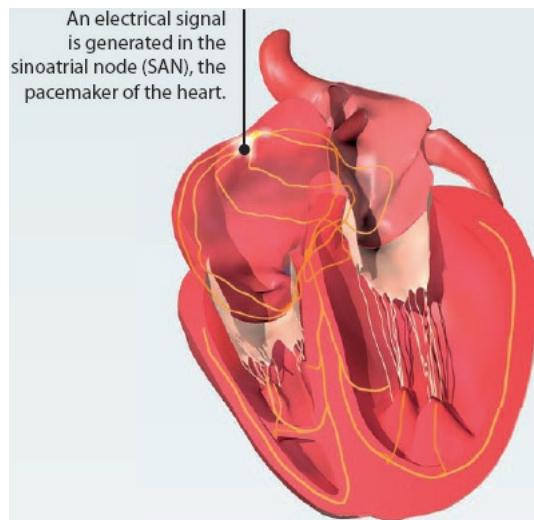
CORONARY CONDUCTION

The heart has its own rhythmic “beat” generator located in the right atrium. This sends regular electrical signals, via specialized rapidly conducting cells, to the rest of the heart. These electrical signals instruct the cardiac muscle cells (cardiomyocytes) of the atria and ventricles to contract, causing the heart to beat and pump blood around the body. The rate at which signals are generated can be varied, and depends upon the needs of the body, i.e. increased in exercise, and decreased at rest.

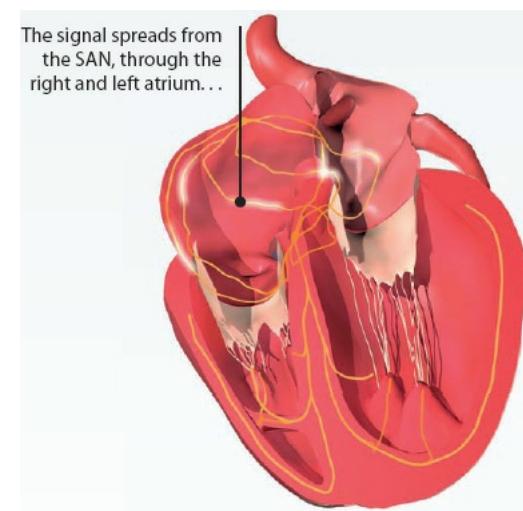
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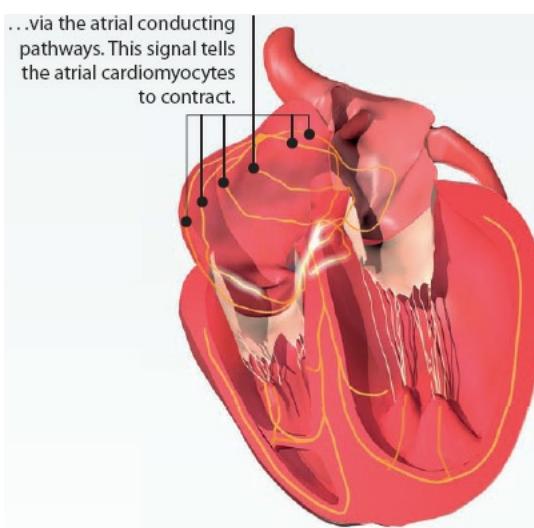
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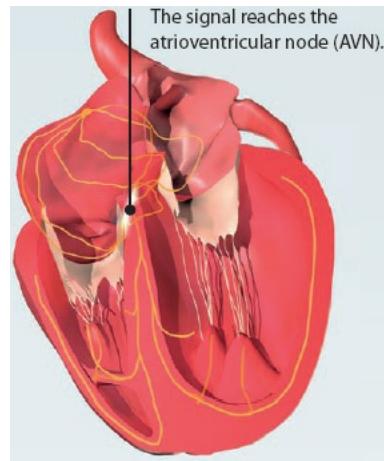
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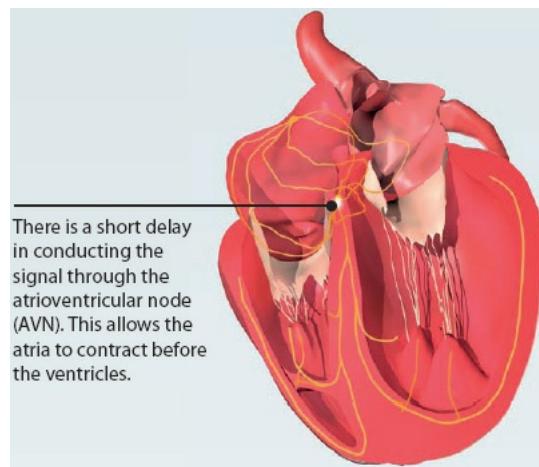
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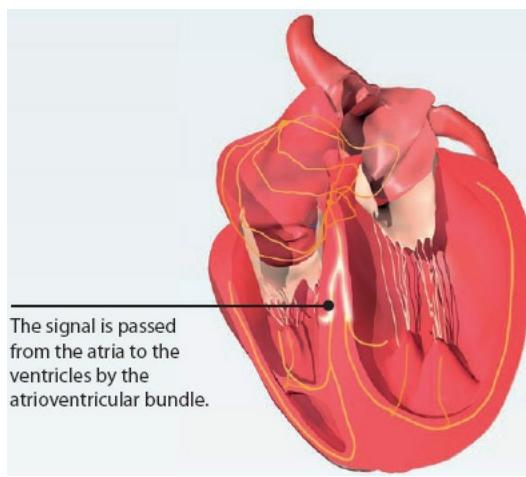
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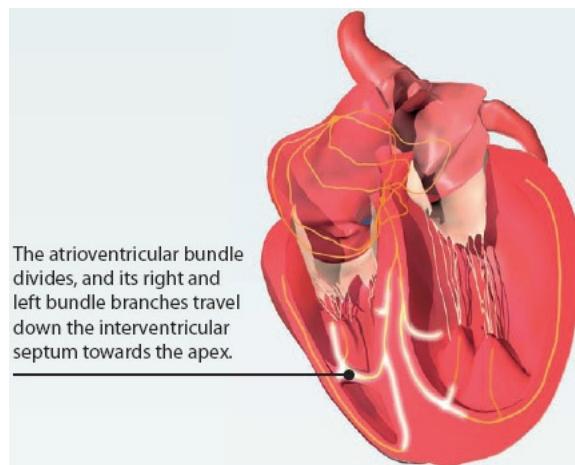
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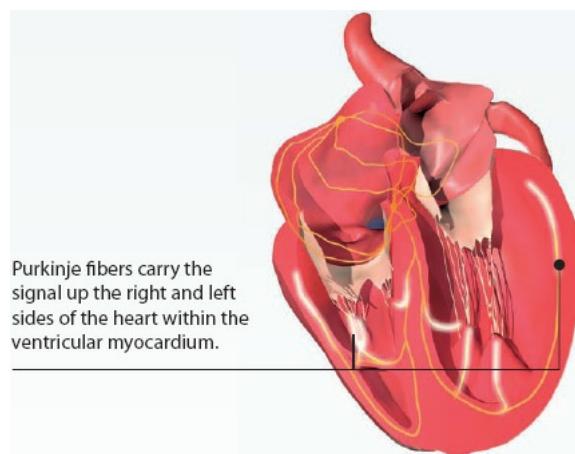
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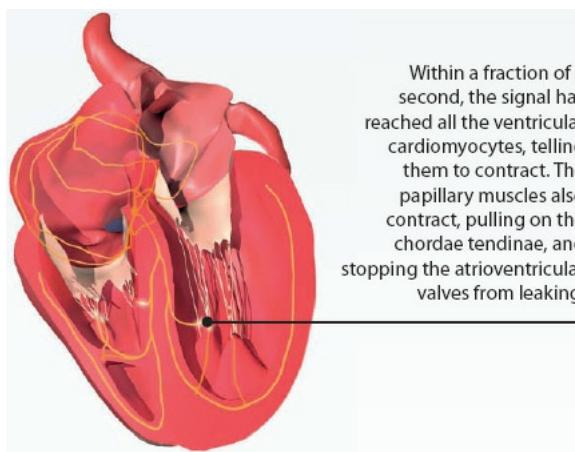
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9



10



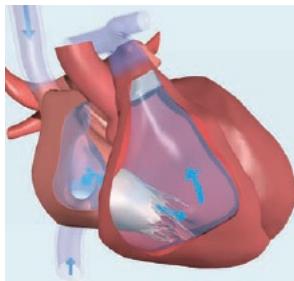
CARDIAC CYCLE

The cardiac cycle is the ordered sequence of events that take place with each beat of the heart. Events happen on the right and left sides of the heart at the same time.

The right side of the heart pumps deoxygenated blood to the lungs, around the pulmonary circuit. The left side of the heart pumps oxygenated blood to the rest of the body, around the systemic circuit. Contraction of a heart

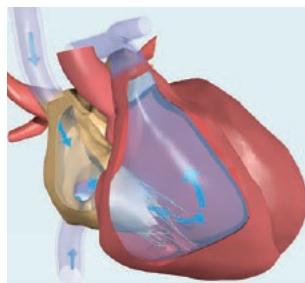
chamber is called systole. Relaxation of a heart chamber is called diastole.

1



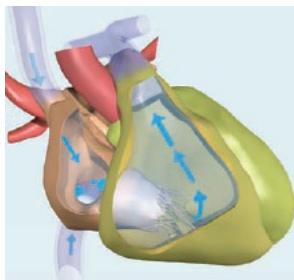
Blood flows into the relaxed right ventricle (ventricular diastole) through the open tricuspid valve.

2



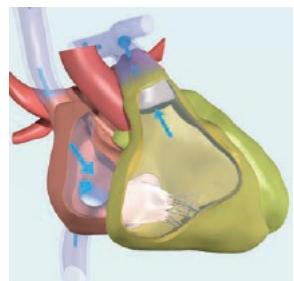
The right atrium contracts (atrial systole) squeezing more blood into the right ventricle.

3



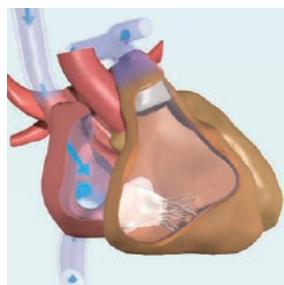
The right ventricle starts to contract (ventricular systole) while the right atrium starts to relax (atrial diastole).

4



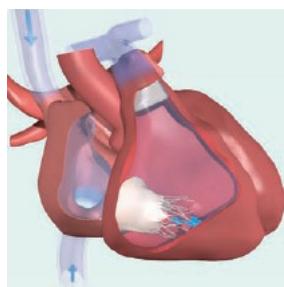
The tricuspid valve closes and the pulmonary valve opens. Blood flows from the right ventricle to the lungs.

5



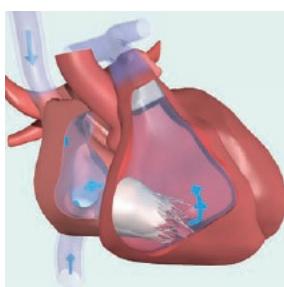
The right ventricle starts to relax. Deoxygenated blood from the superior and inferior vena cavae fills the right atrium.

6



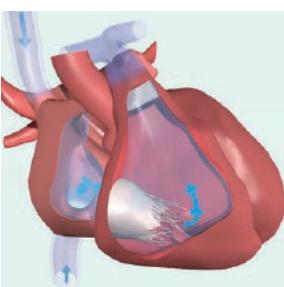
The tricuspid valve opens and blood starts to flow into the right ventricle from the right atrium.

7



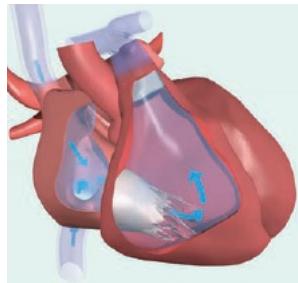
The pulmonary valve remains closed while the right ventricle fills with blood.

8



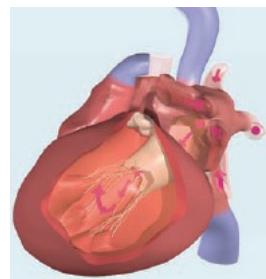
The right atrium and ventricle are both relaxed.

9



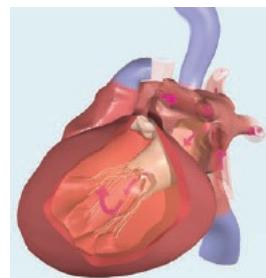
The right ventricle expands as it fills with blood.

1



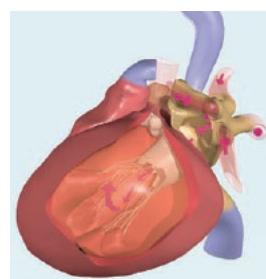
The left atrium and ventricle are both relaxed.

2



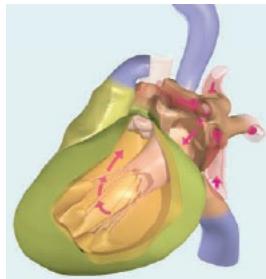
Blood flows into the relaxed left ventricle through the open mitral valve.

3



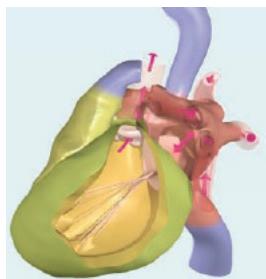
The left atrium contracts, squeezing more blood into the left ventricle.

4



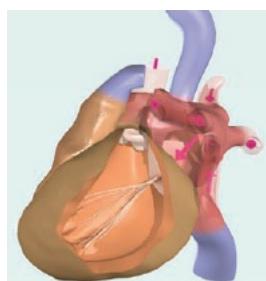
The left ventricle starts to contract while the left atrium starts to relax.

5



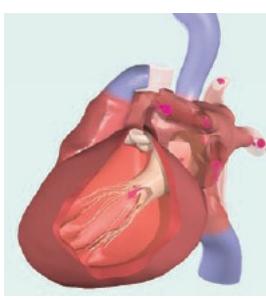
The mitral valve closes and the aortic valve opens. Blood flows from the left ventricle to the aorta and rest of the body.

6



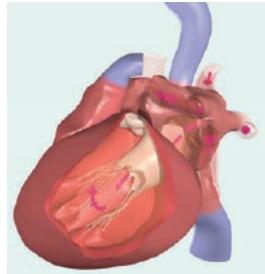
The left ventricle starts to relax. Pulmonary veins carry oxygenated blood from the lungs to fill the left atrium.

7



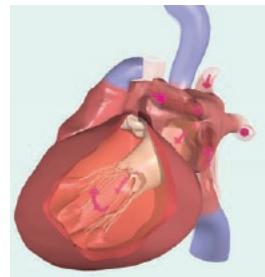
The mitral valve opens and blood starts to flow into the left ventricle from the left atrium.

8



The aortic valve remains closed while the left ventricle fills with blood

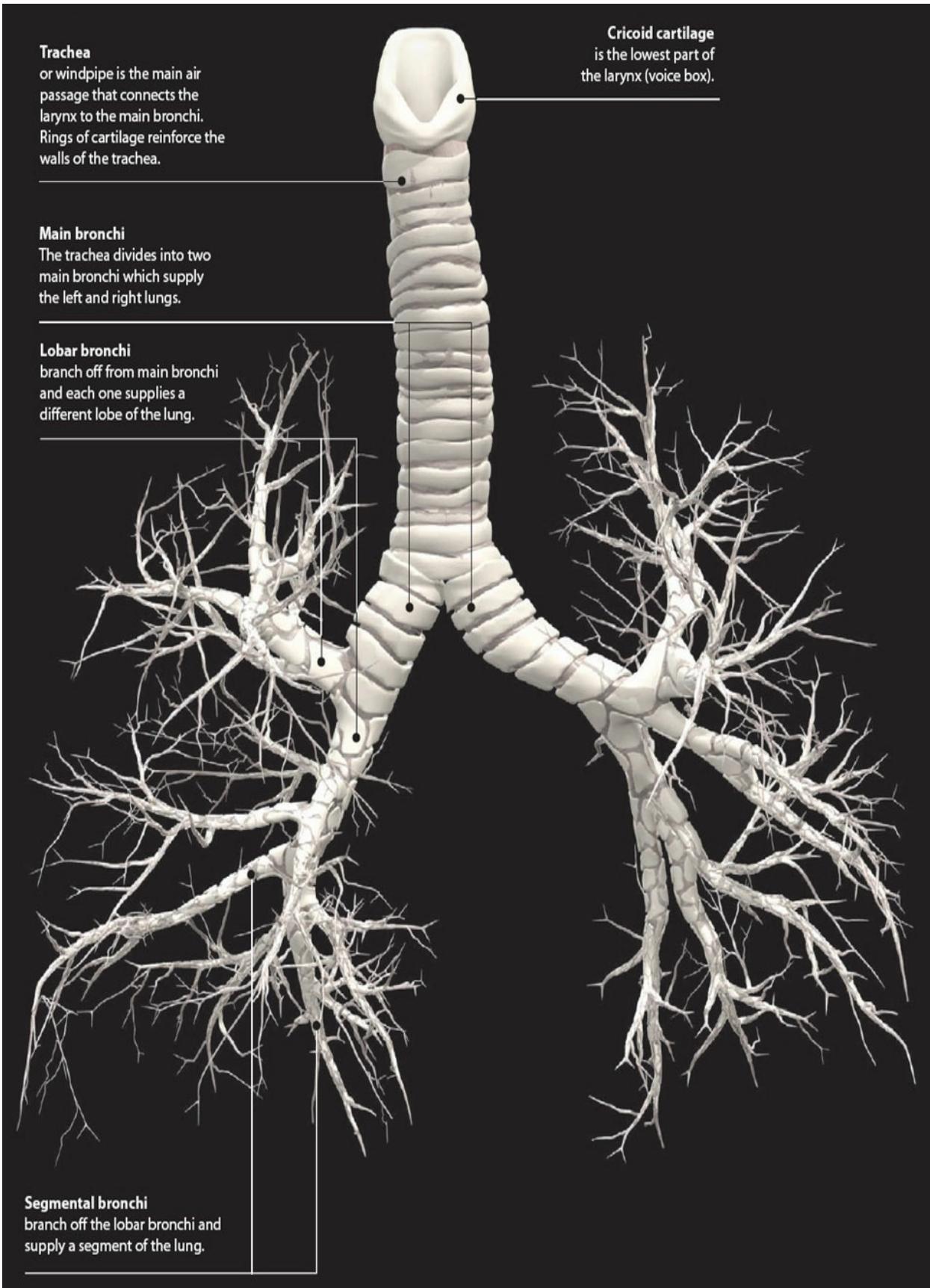
9



The left ventricle expands as it fills with blood.

LUNGS AND BRONCHIAL TREE

The lungs are contained within our rib cage. They are like balloons that inflate and deflate with each breath, and can hold around 12 pints of air. There are numerous air passages in the lung that repeatedly branch and divide, starting with the trachea and bronchi, and ending eventually at the alveoli.



Lobes

Each lung is divided into lobes. There are three lobes in the right lung (upper, middle, and lower), and two lobes in the left lung (upper and lower). The lobes are further divided into segments.

Fissures

are narrow grooves on the lung surface that divide the lung into lobes.

Right inferior lobe

Right superior lobe

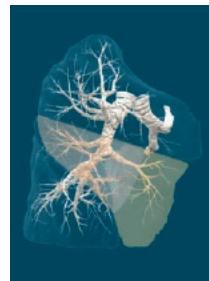
Right middle lobe

Trachea

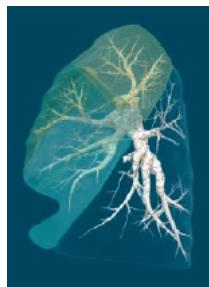
Heart



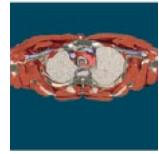
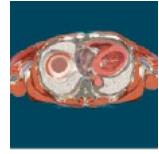
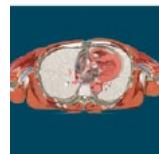
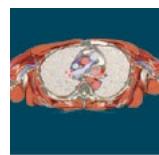
The lungs are enclosed within a thin membranous sac called the pleura. The pleura covers the surface of the lungs and lines the inside of the rib cage. It produces a small amount of fluid, which acts like a lubricant, allowing the lungs to move freely within the rib cage every time we breathe.



Left superior lobe



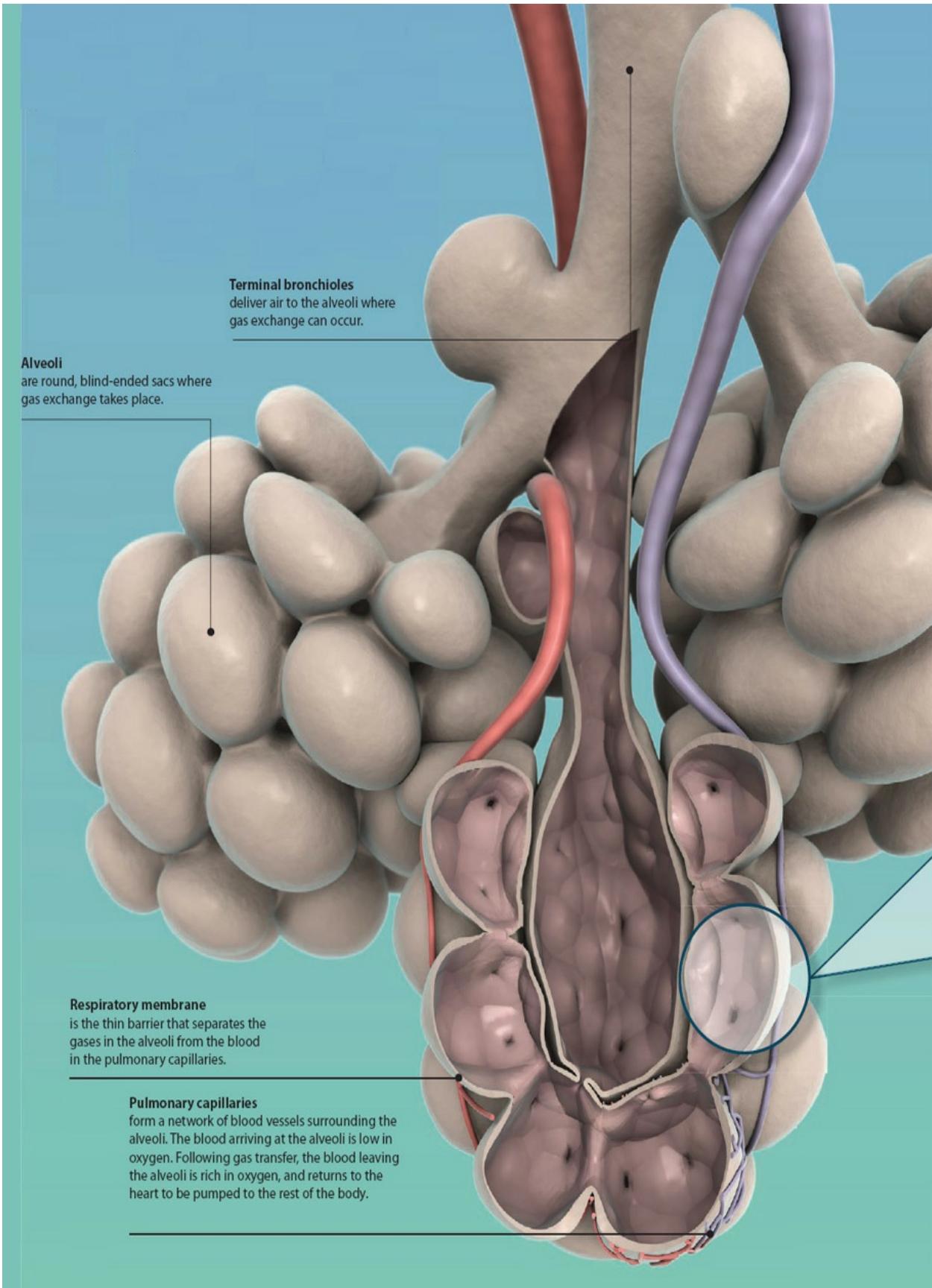
Left inferior lobe

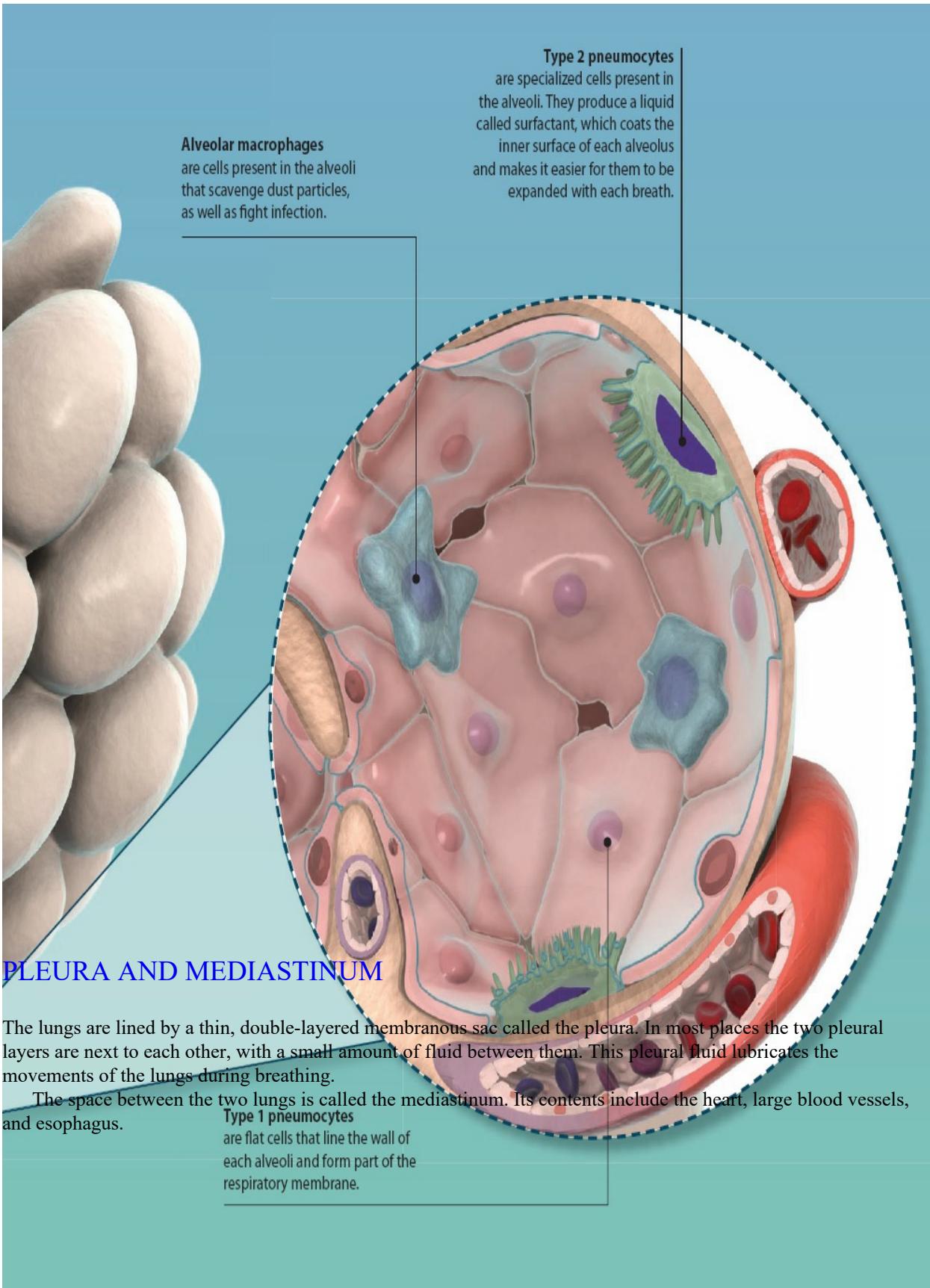


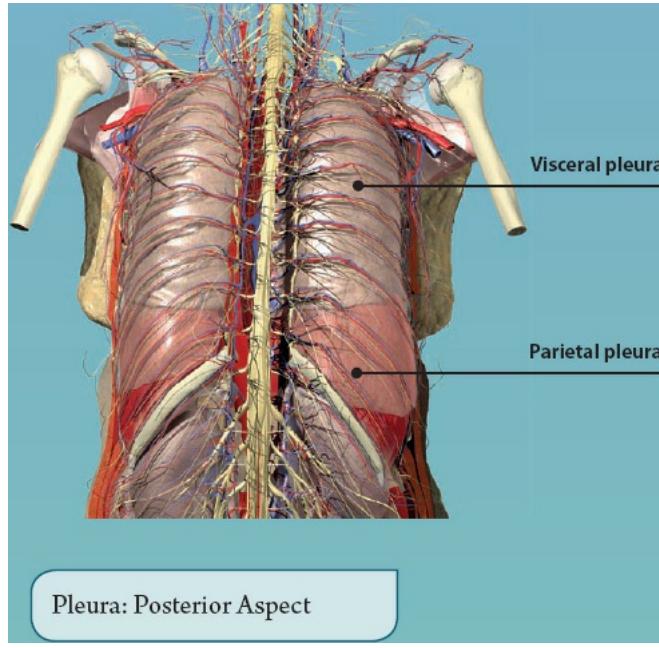
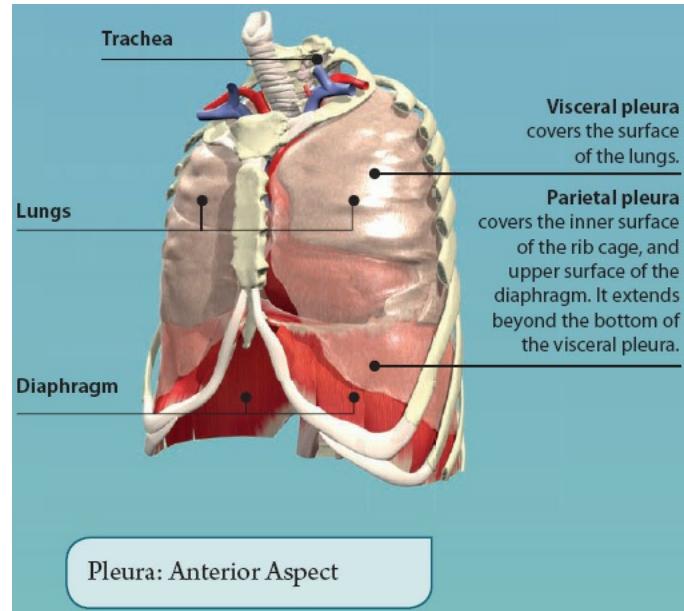


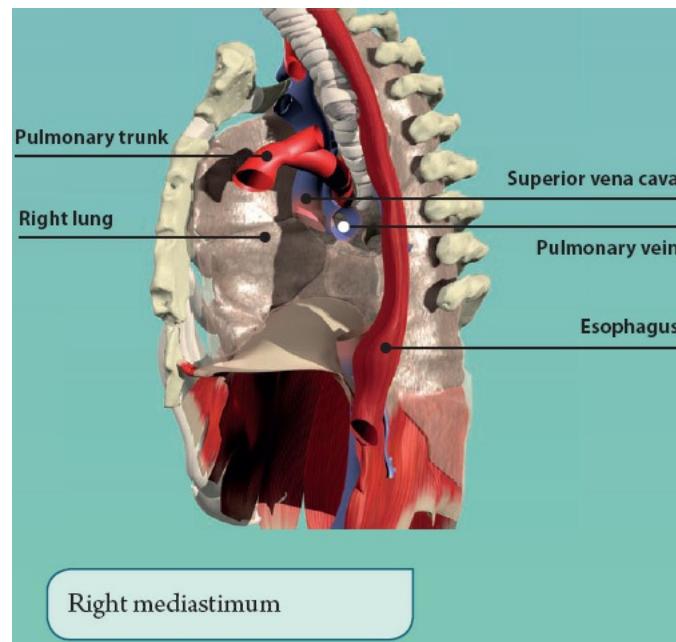
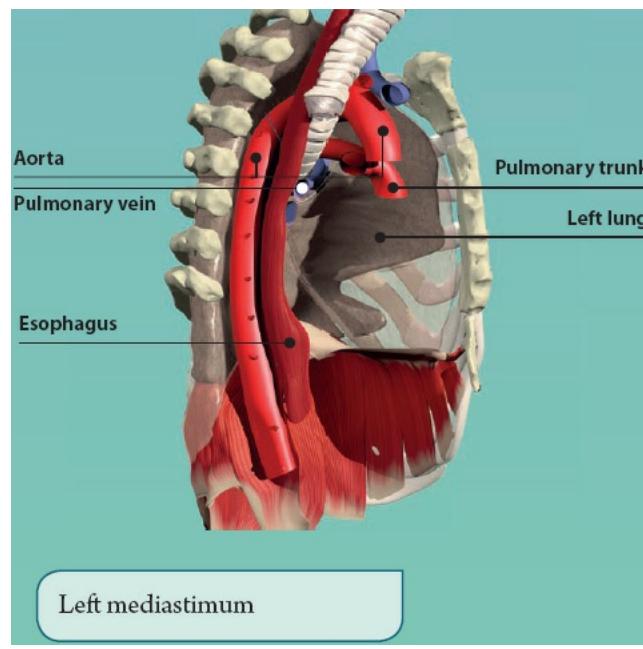
ALVEOLI AND RESPIRATORY MEMBRANE

After dividing and branching up to twenty-five times, the bronchial tree eventually forms the terminal bronchioles, which deliver air to the alveoli. Within each of the individual alveoli, oxygen from the air is transferred into the blood, and excess carbon dioxide removed from it, in a process called gas exchange. This takes place across a thin barrier called the respiratory membrane.



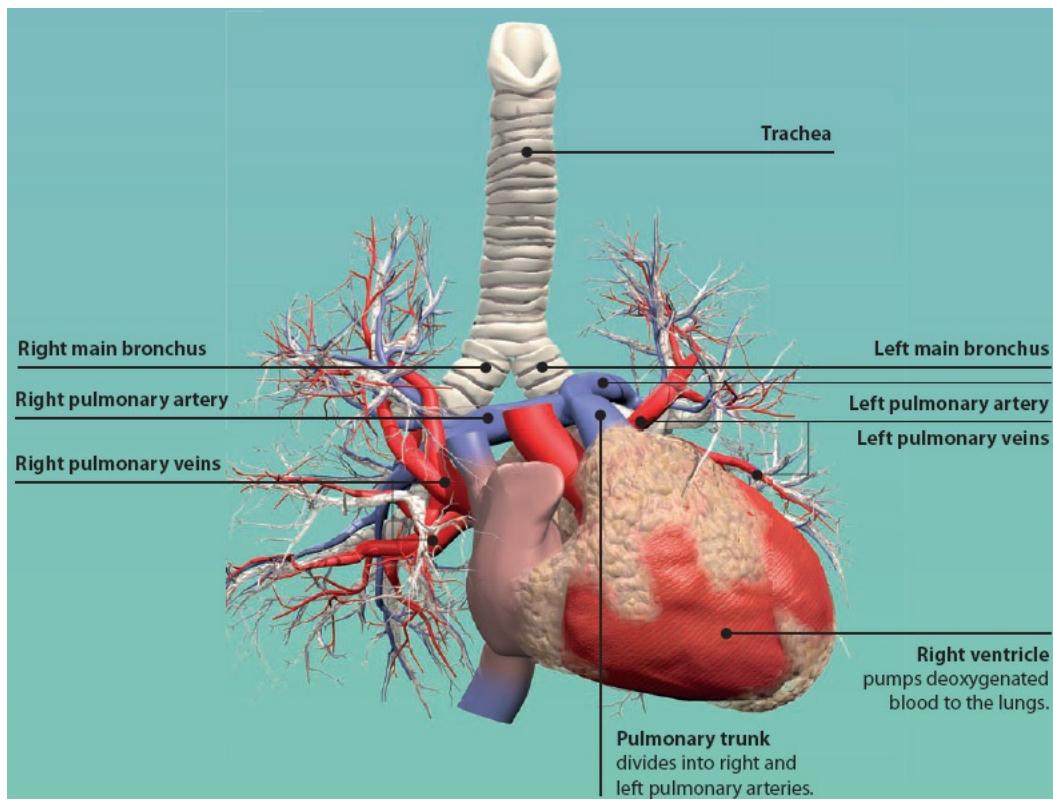
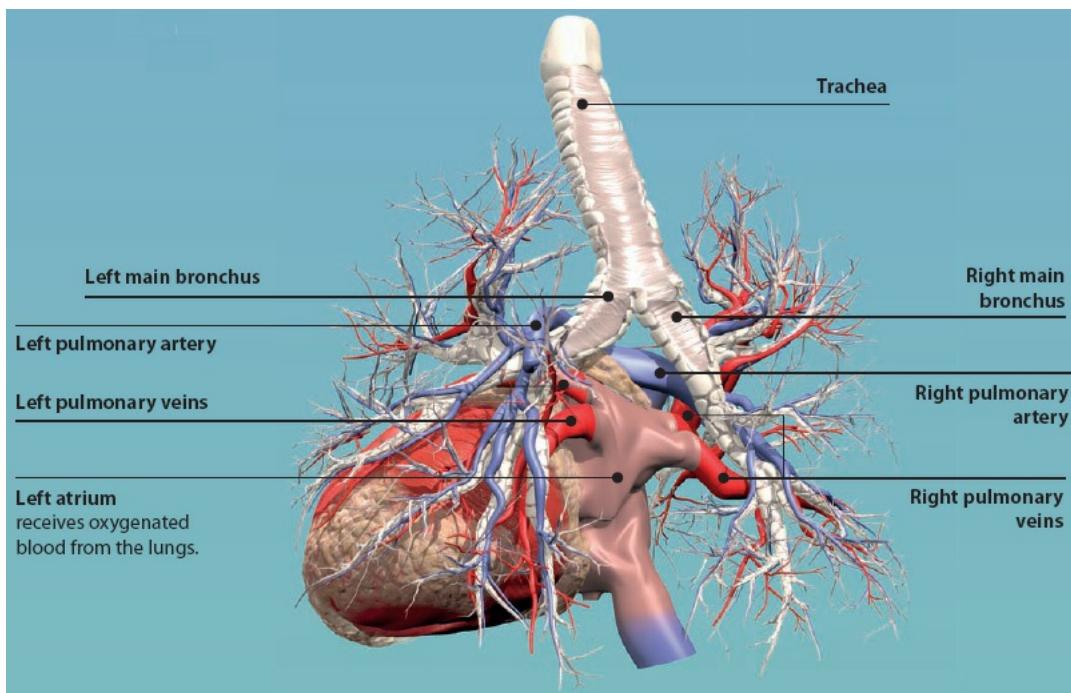


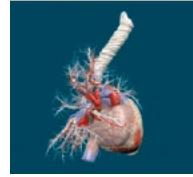
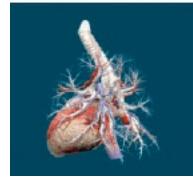
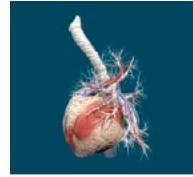
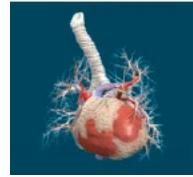
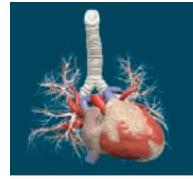




PULMONARY VESSELS

The two pulmonary arteries deliver deoxygenated blood to the lungs from the right ventricle. The four pulmonary veins return the oxygenated blood from the lungs to the left atrium. Branches of the pulmonary vessels accompany the bronchi to supply a segment of the lung.

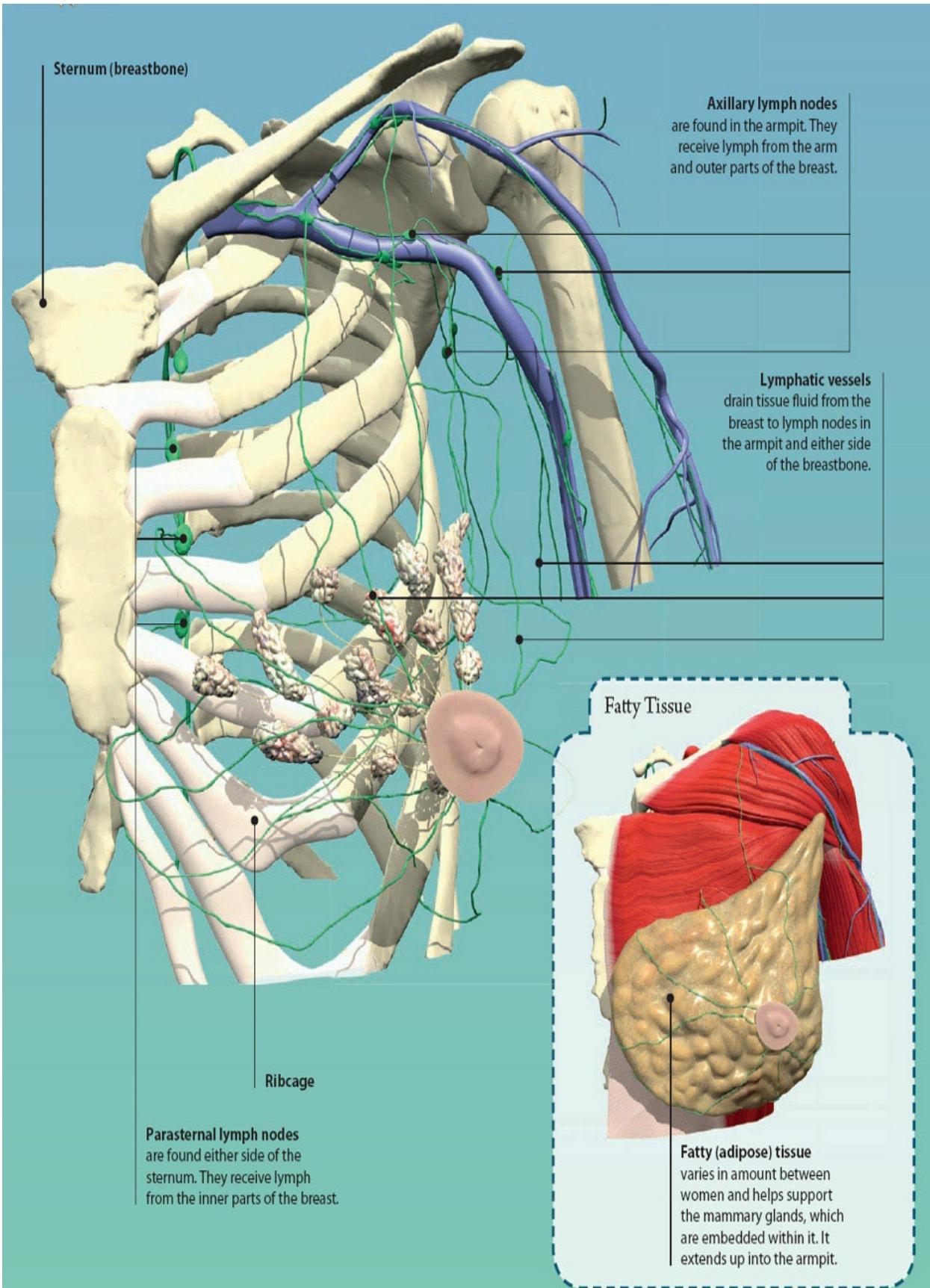


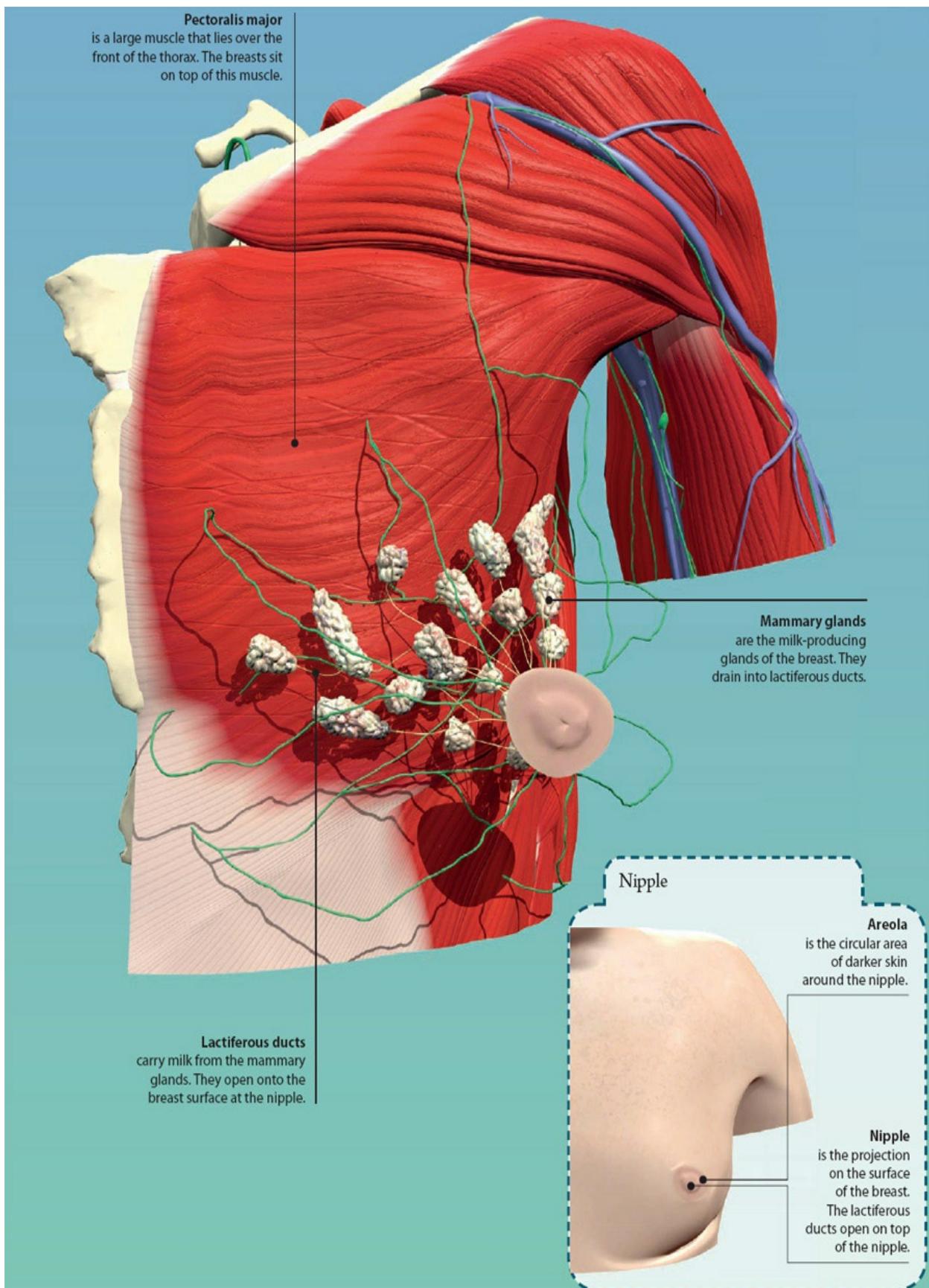


BREAST AND MAMMARY GLANDS

The breasts form paired, variably sized mounds, on the front of the thorax. They are made up of fatty, glandular, and

connective tissues. Female hormones such as estrogen cause the breast tissues to grow and develop, particularly at puberty and during pregnancy. The mammary glands of the breast produce milk.

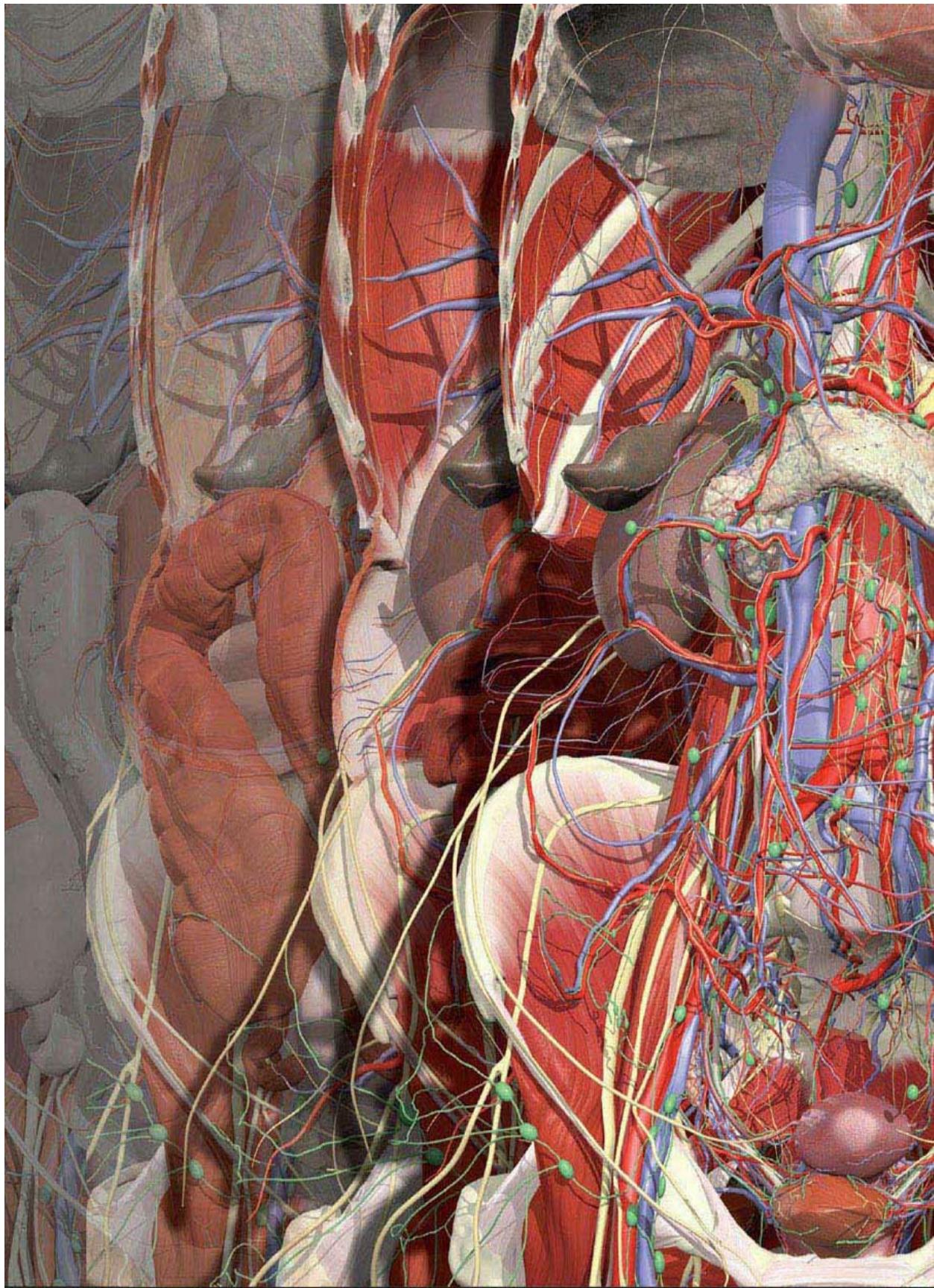


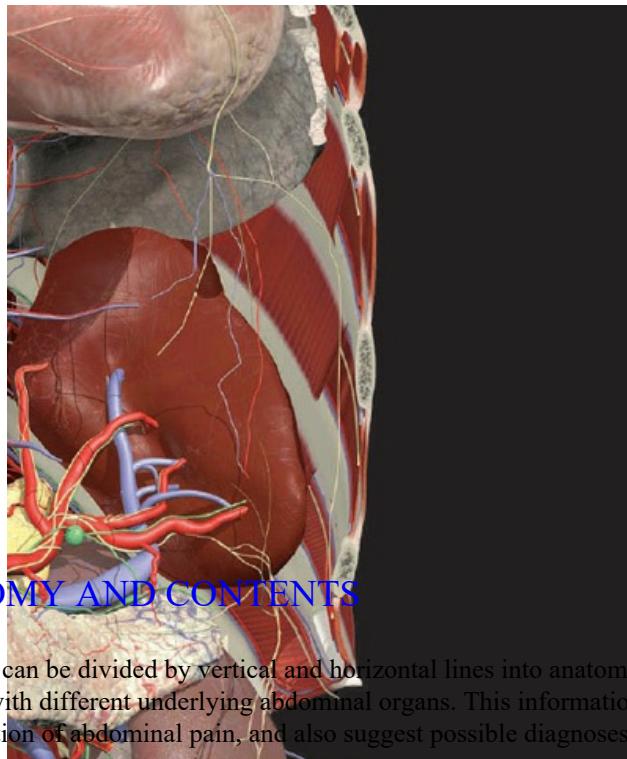


CHAPTER 5: THE ABDOMEN

The abdomen forms the lower part of the trunk. It extends from the diaphragm above to the pelvis below. The space inside the abdomen is called the abdominal cavity. It contains most of the organs of the digestive system, including the stomach, liver, pancreas, the small intestine, and part of the large intestine. The kidneys and ureters are found on the back wall of the abdomen.

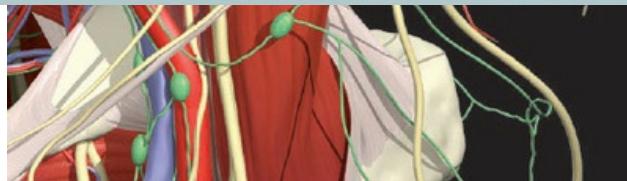
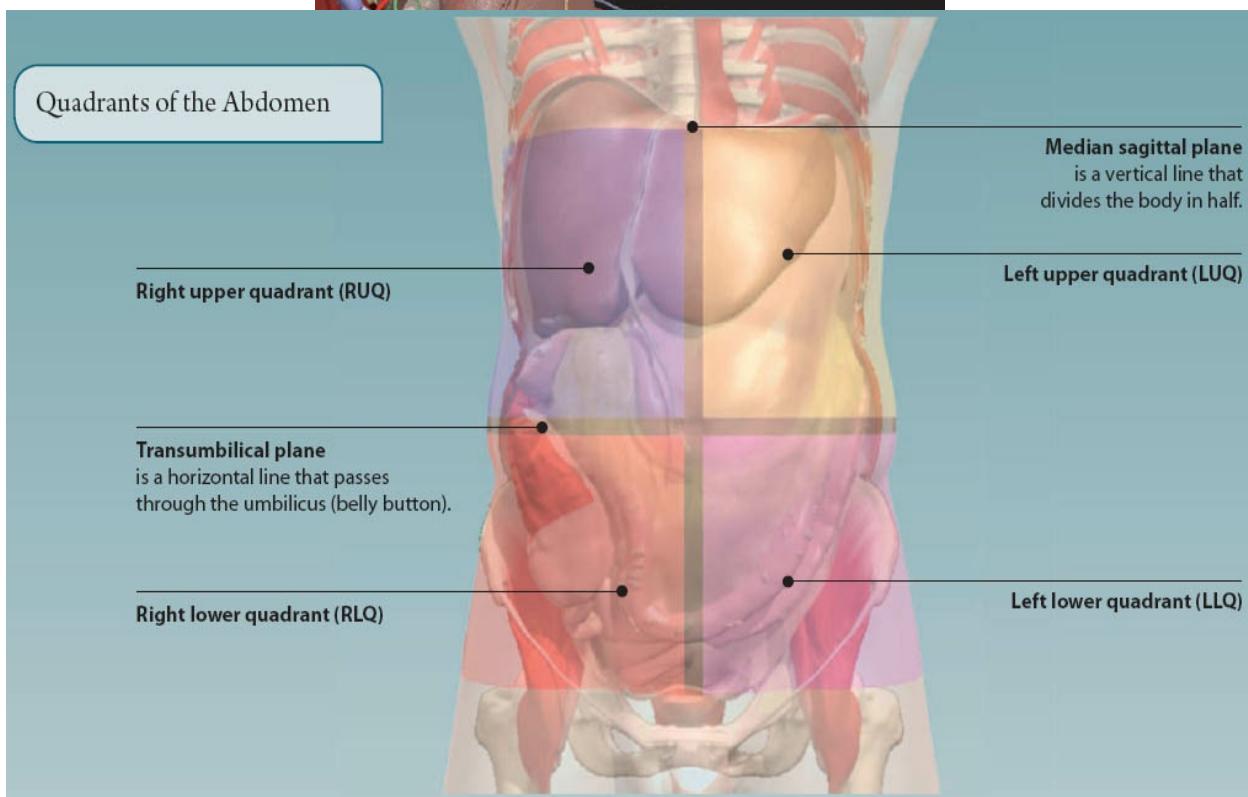
The walls of the abdomen are mainly formed from layers of muscles, which can bend the trunk forward and from side to side. These muscles are also able to generate large changes in the size and pressure of the abdominal cavity. This helps with bodily functions such as breathing and going to the toilet.

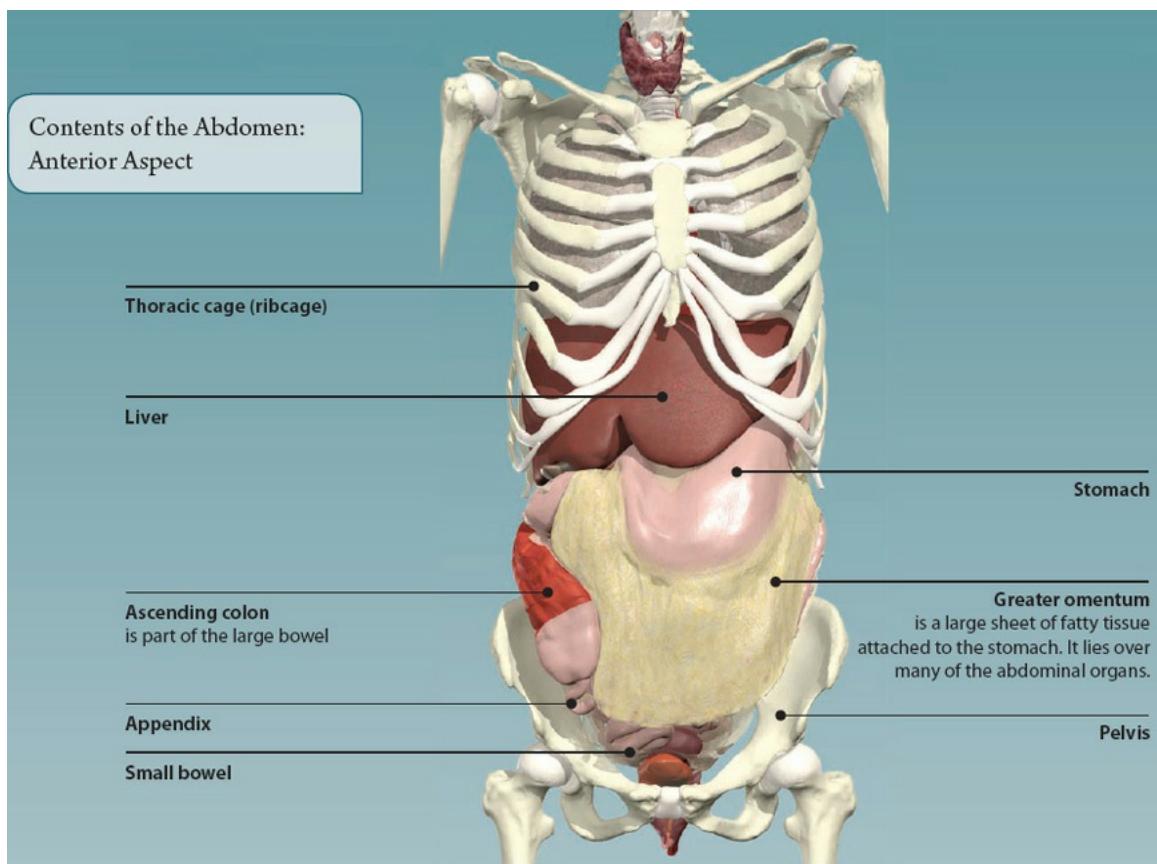
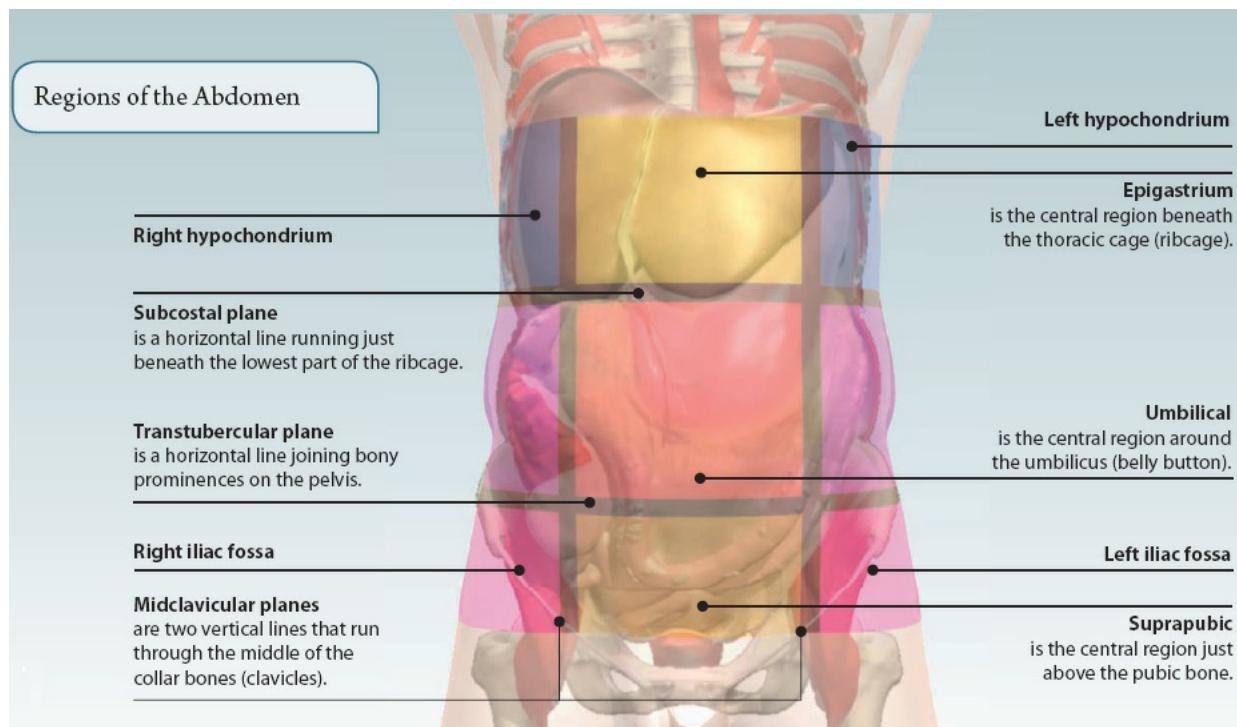




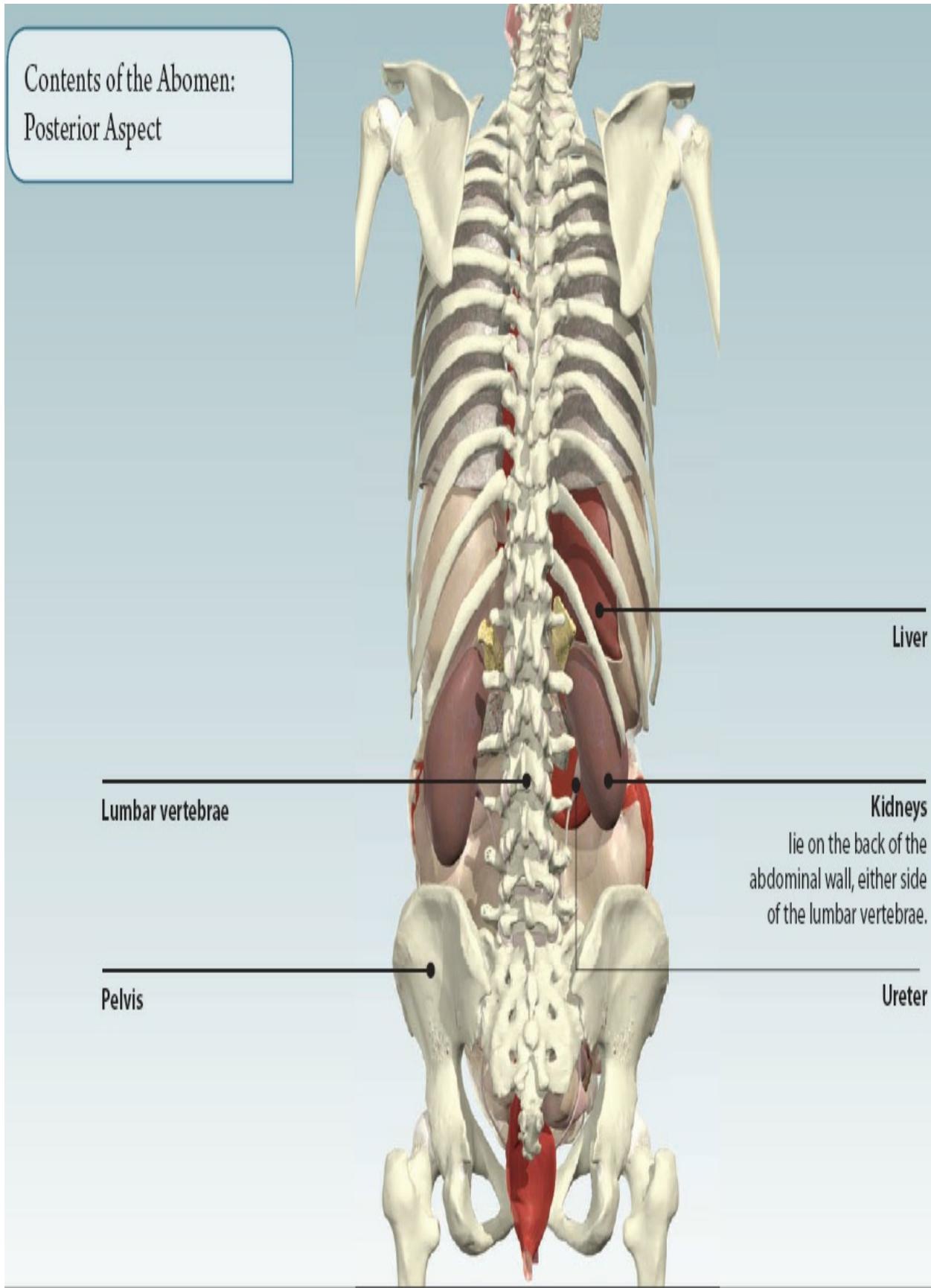
SURFACE ANATOMY AND CONTENTS

The surface of the abdomen can be divided by vertical and horizontal lines into anatomical regions or quadrants. These areas are associated with different underlying abdominal organs. This information can be used by doctors to accurately describe the position of abdominal pain, and also suggest possible diagnoses.





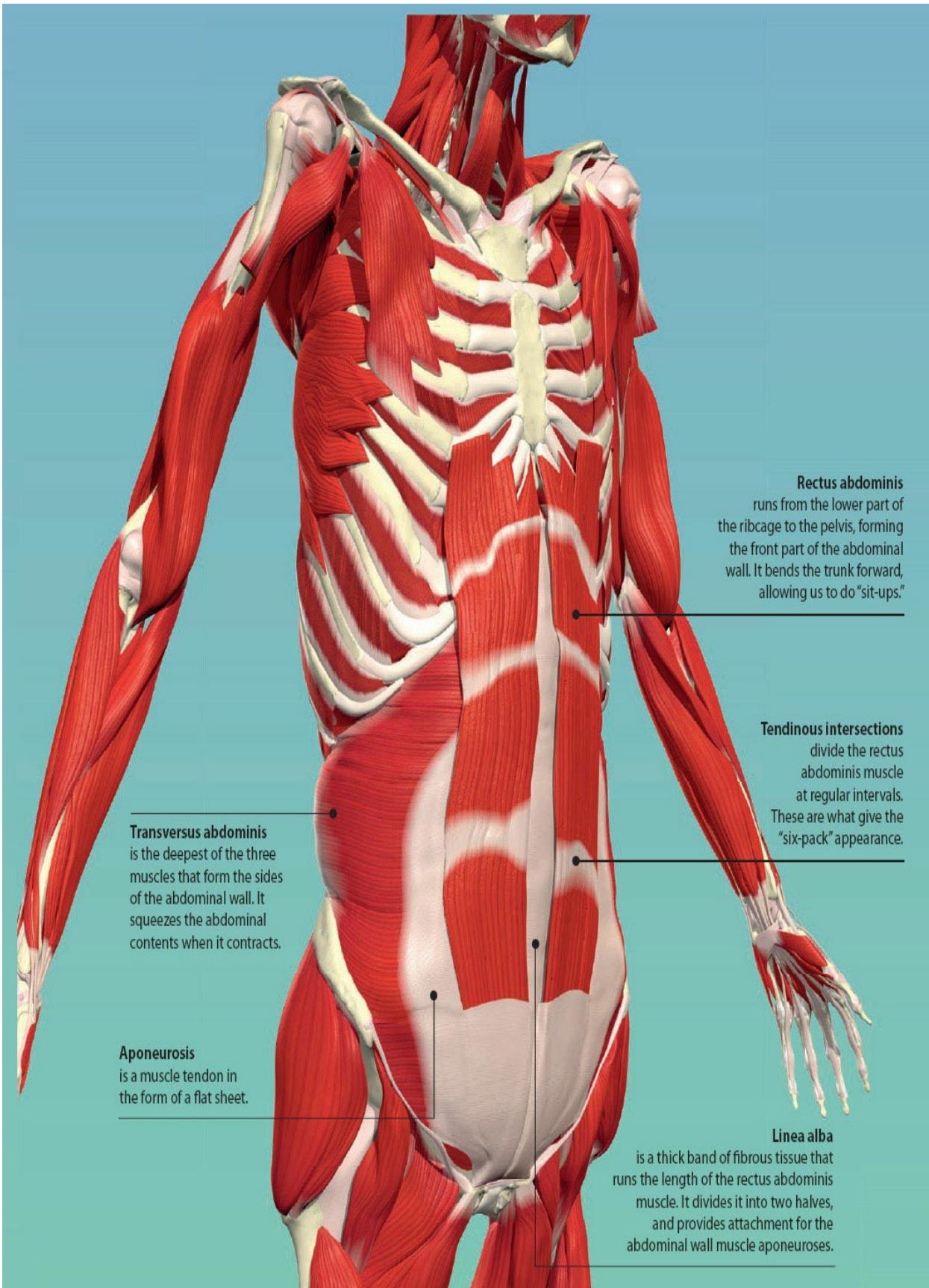
Contents of the Abdomen:
Posterior Aspect



MUSCLES OF THE ABDOMEN

Muscles, and tendon sheets called aponeuroses, form a large part of the abdominal wall. They move the trunk, protect the abdominal contents, and have an important role in increasing the pressure in the abdominal cavity. This is vital for processes such as breathing, childbirth, vomiting, and going to the toilet.

Three flattened muscles—external oblique, internal oblique, and transverse abdominis—form the side walls of the abdomen. Their aponeuroses combine together at the front to enclose the rectus abdominis muscle.



Posterior Abdominal Wall

Diaphragm

Quadratus lumborum

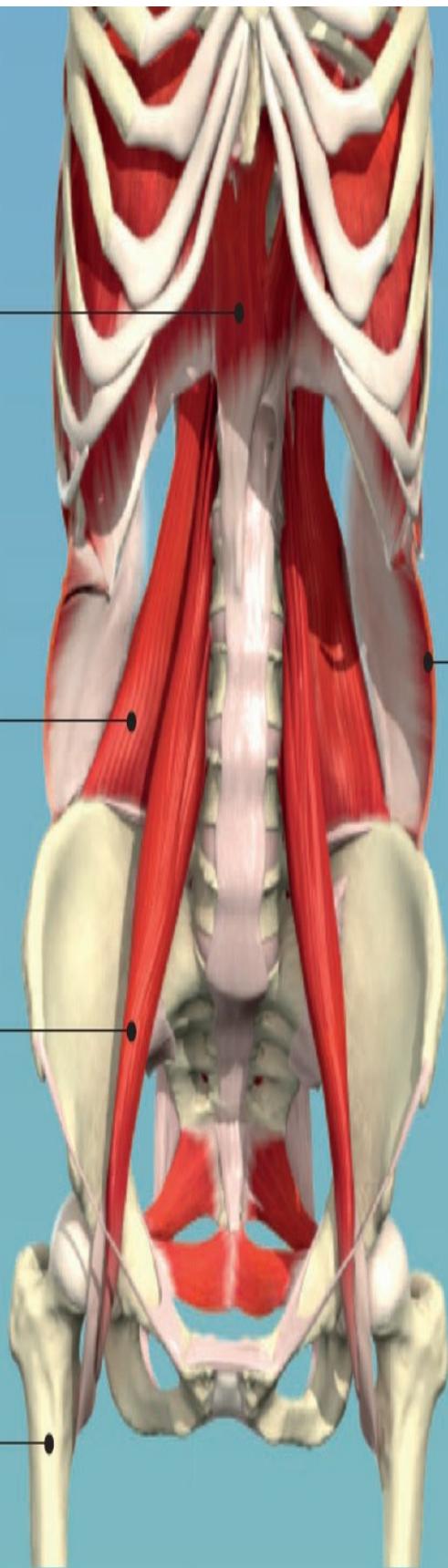
forms part of the abdominal wall at the back. It bends the trunk to the sides.

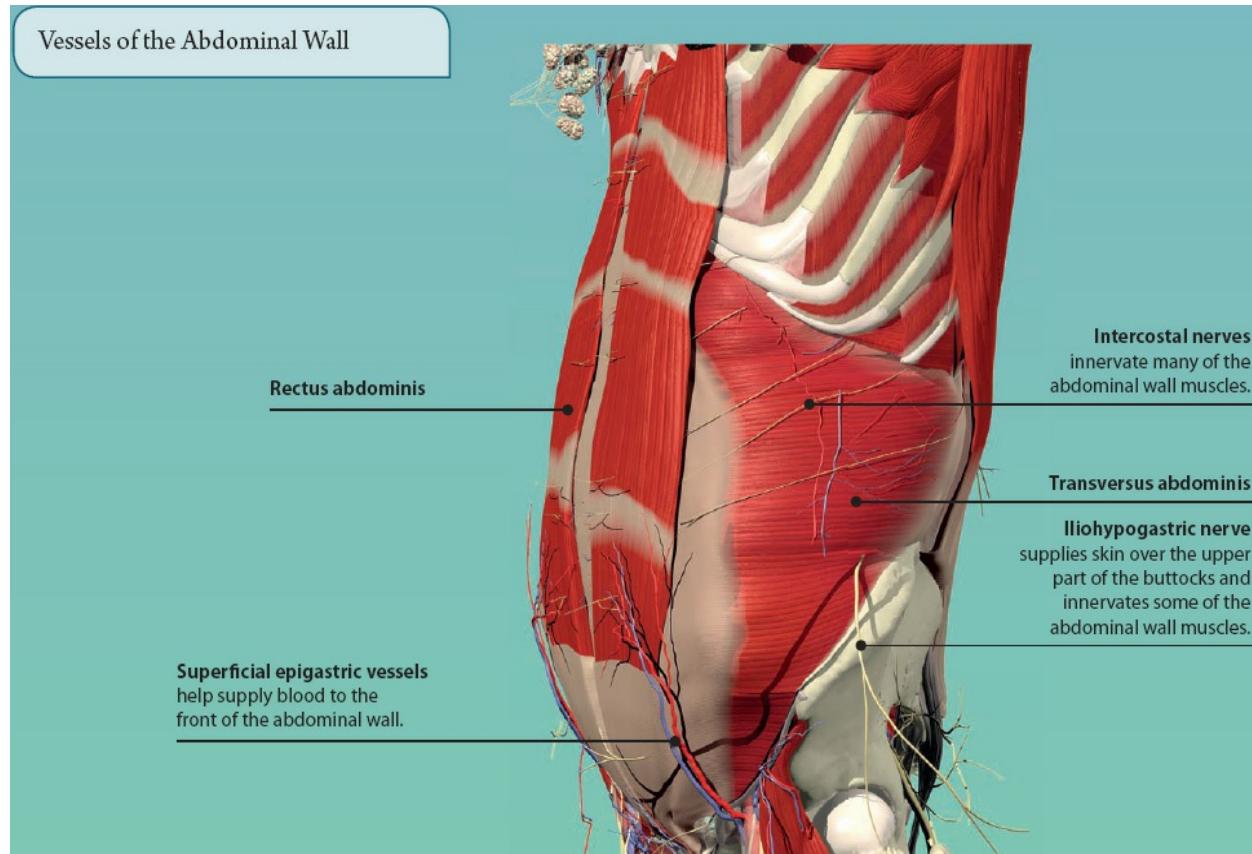
Transversus abdominis

Psoas major

is attached to the femur. It helps bend the trunk forward.

Femur (thigh bone)



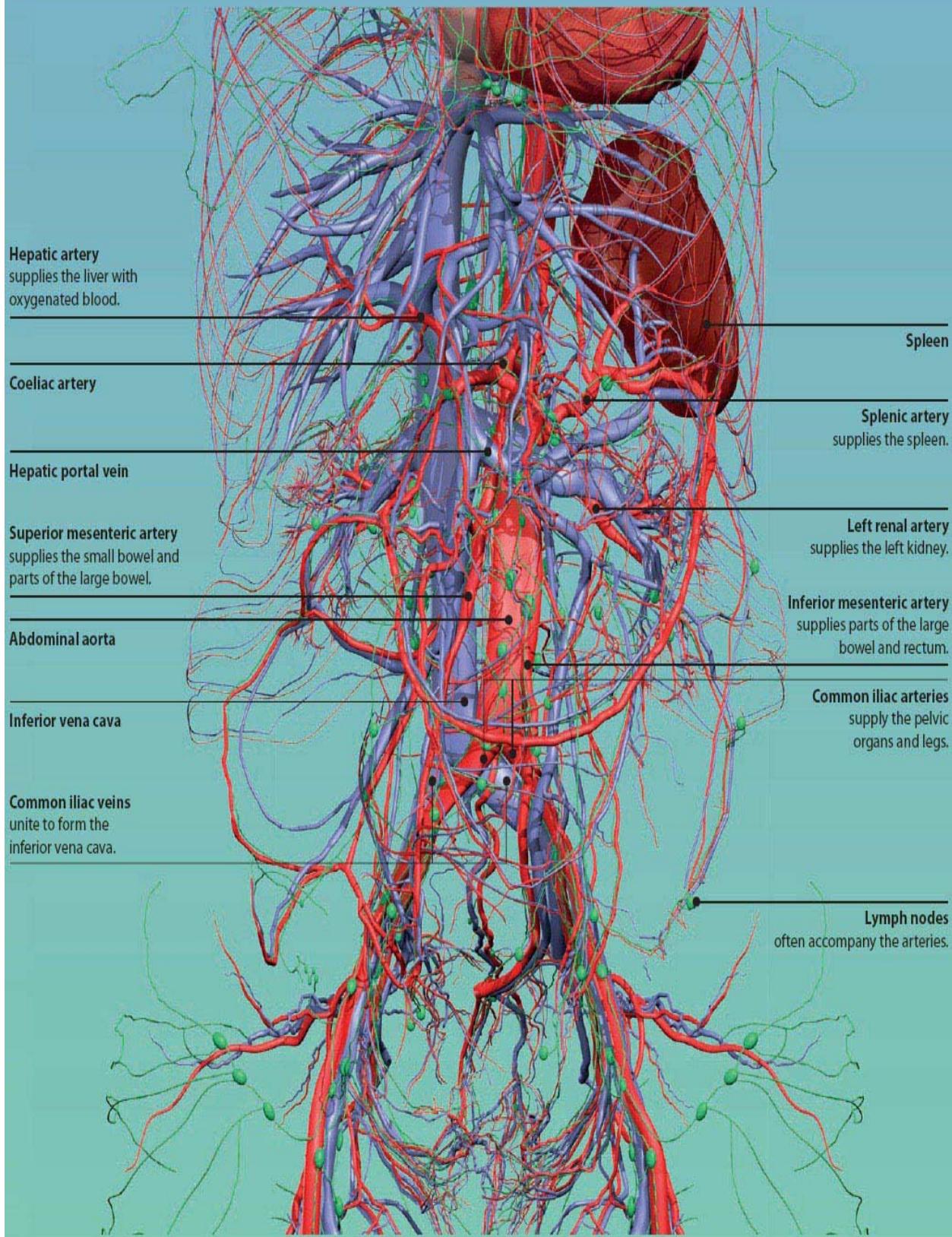


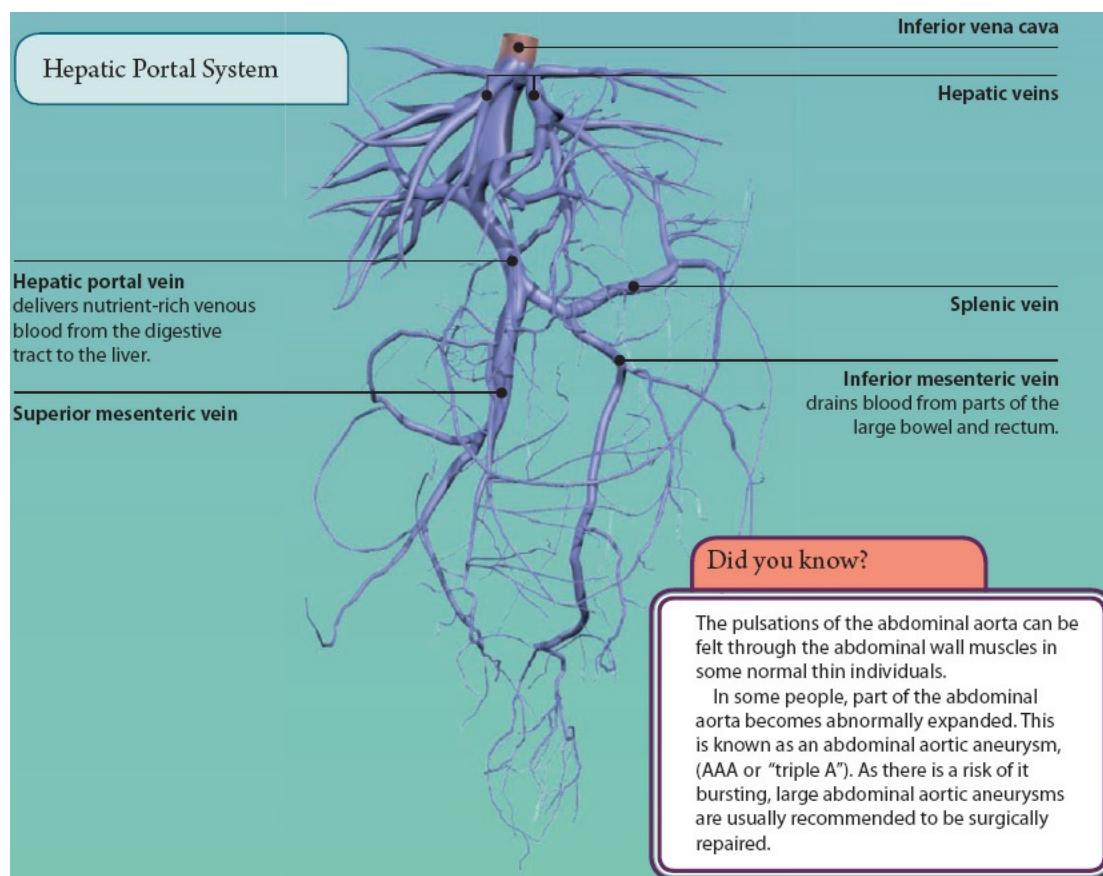
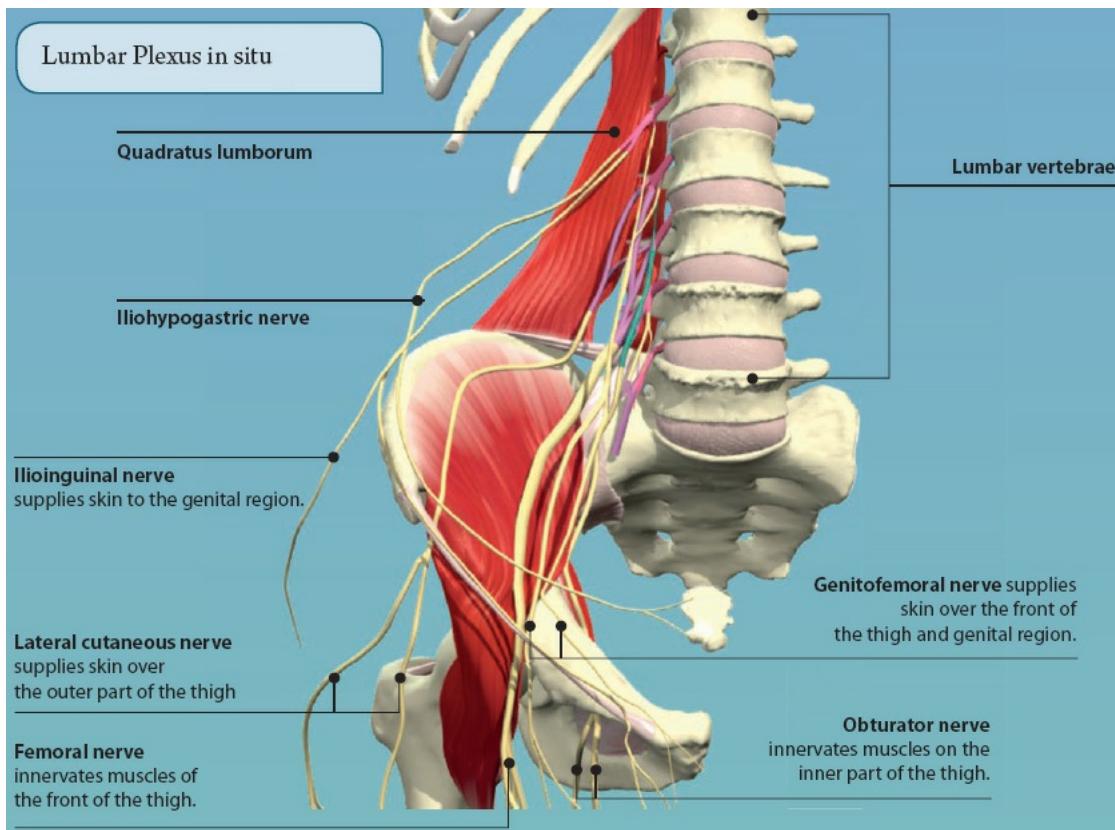
NEUROVASCULAR STRUCTURES OF THE ABDOMEN

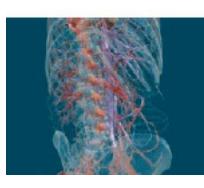
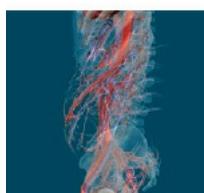
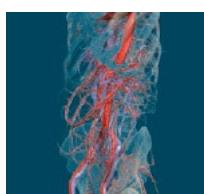
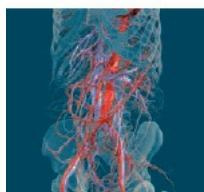
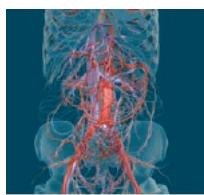
The abdominal organs are supplied with blood from branches of the abdominal aorta. The hepatic portal system allows nutrient rich venous blood from the digestive system to be processed by the liver, before draining into the inferior vena cava.

The lumbar plexus is a collection of nerves found at the back of the abdomen. These supply some of the skin of the thigh, leg, and genital region, as well as innervating some of the muscles of the thigh and abdomen.

Vessels of the Abdomen

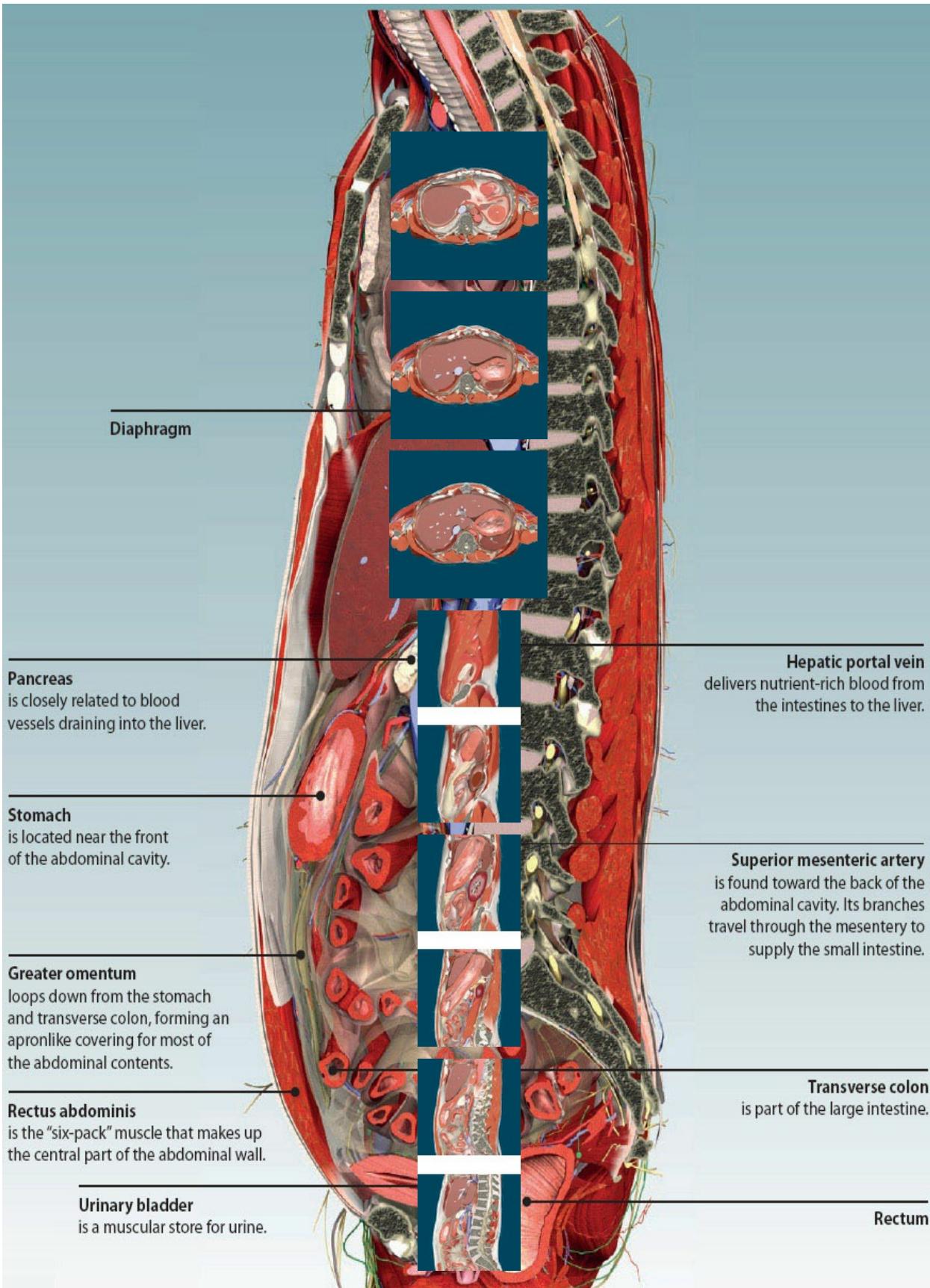


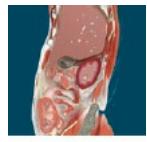


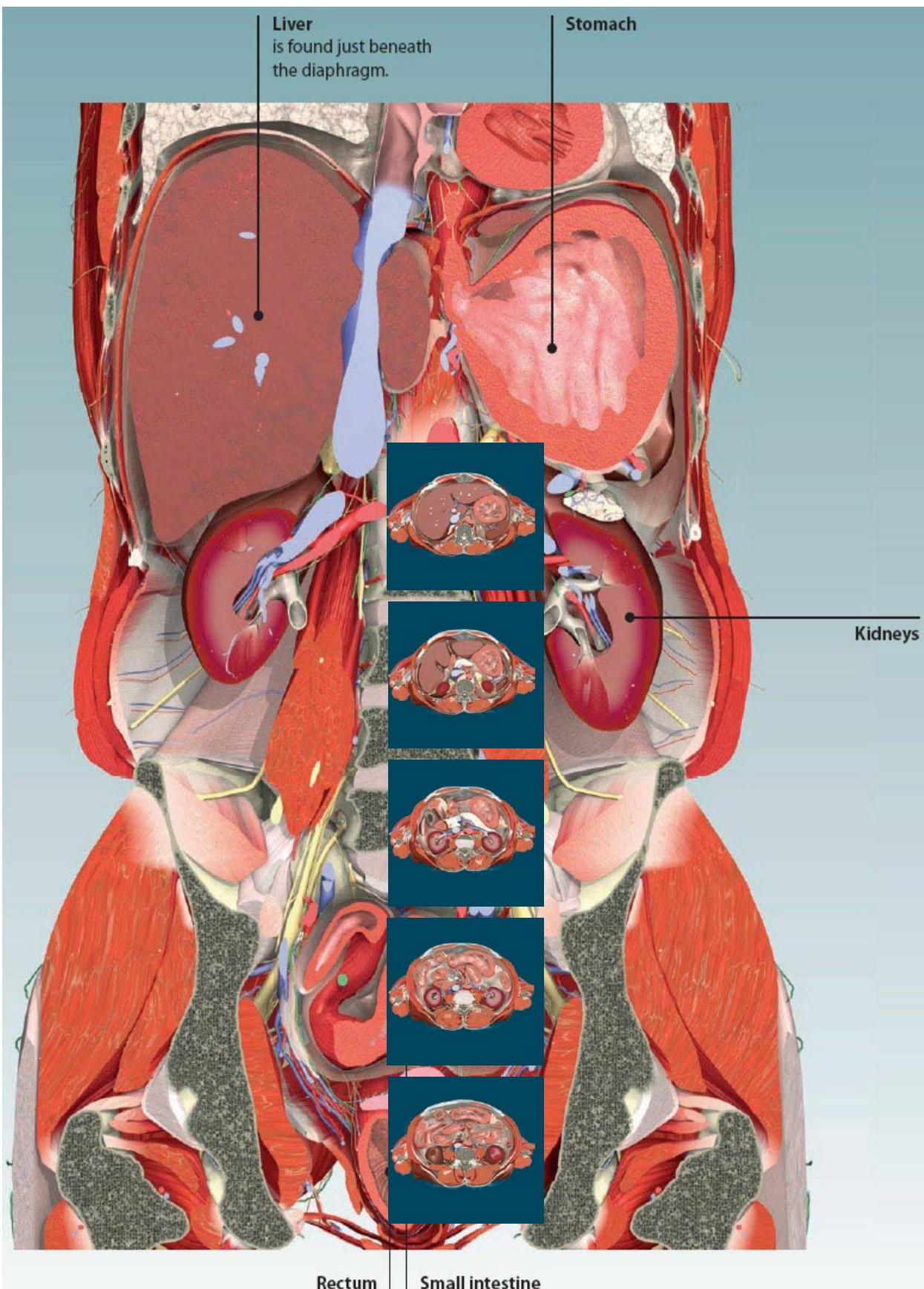


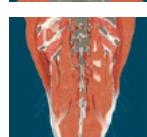
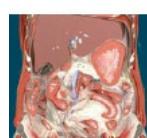
CROSS SECTIONAL IMAGES THROUGH THE ABDOMEN

Viewing the abdomen in different anatomical planes allows us to see how the various organs and structure are arranged and related to one another.





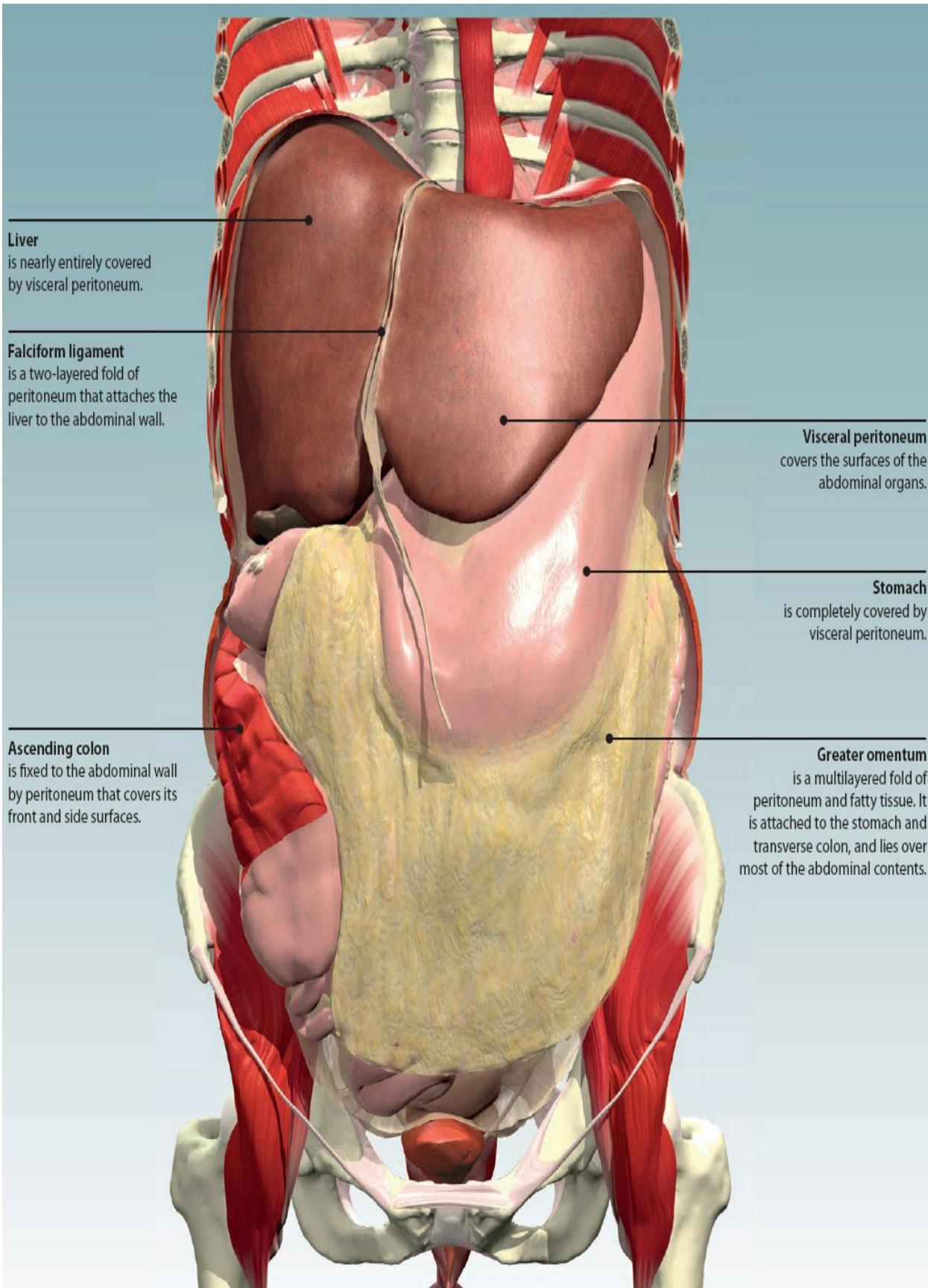


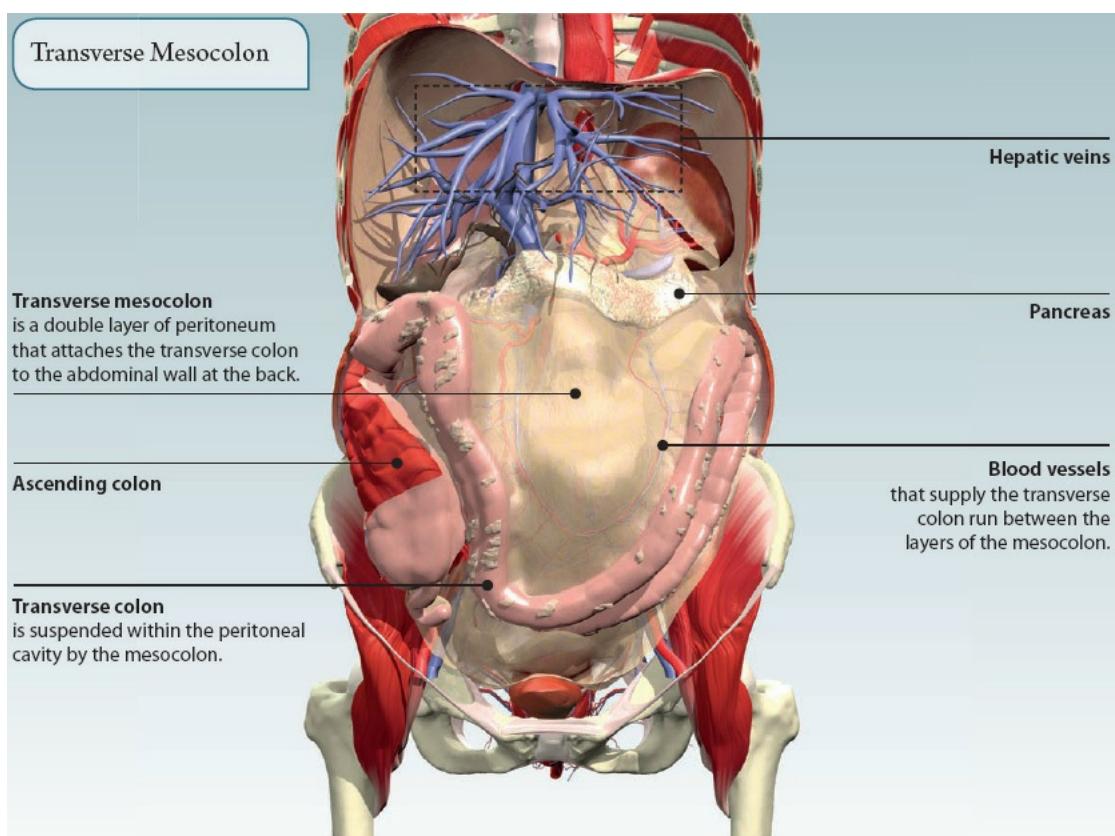
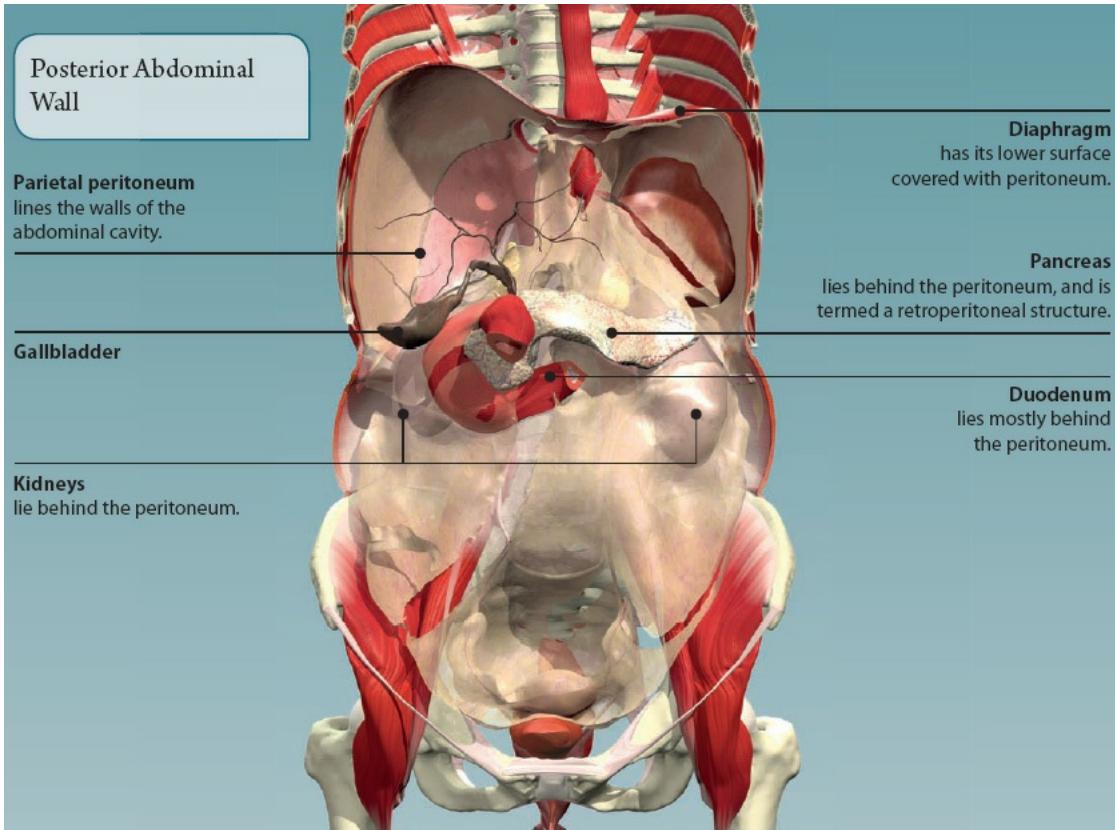


PERITONEUM

The peritoneum is a thin, smooth membrane that coats the walls of the abdominal cavity (parietal peritoneum), as well as some of the organs (visceral peritoneum). The peritoneal cavity is the space between the visceral and parietal peritoneum. It contains a small amount of fluid, which helps fight infection and lubricates the movements of the abdominal organs.

In places the peritoneum forms layered folds, which attach organs to the abdominal wall and carry their blood vessels.

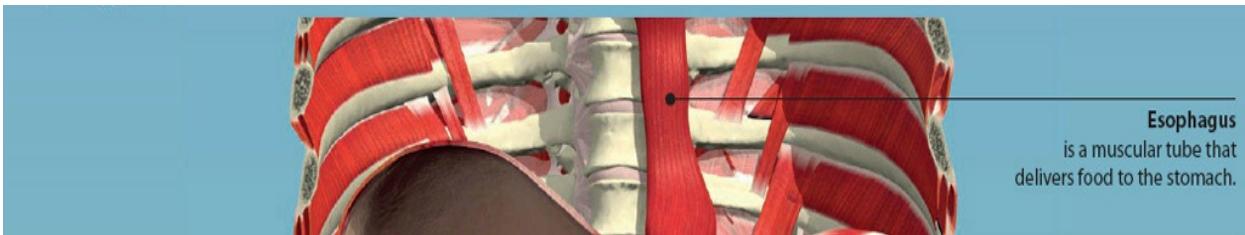




THE STOMACH AND ESOPHAGUS

The stomach is a J-shaped organ that connects the esophagus to the duodenum (the first part of the small intestine). It lies on the left side of the upper abdomen, just beneath the diaphragm.

It is an expandable, muscular sac, which can store, mix, and break down food to produce a thick liquid called chyme. The delivery of chyme to the duodenum is controlled by the pyloric sphincter.



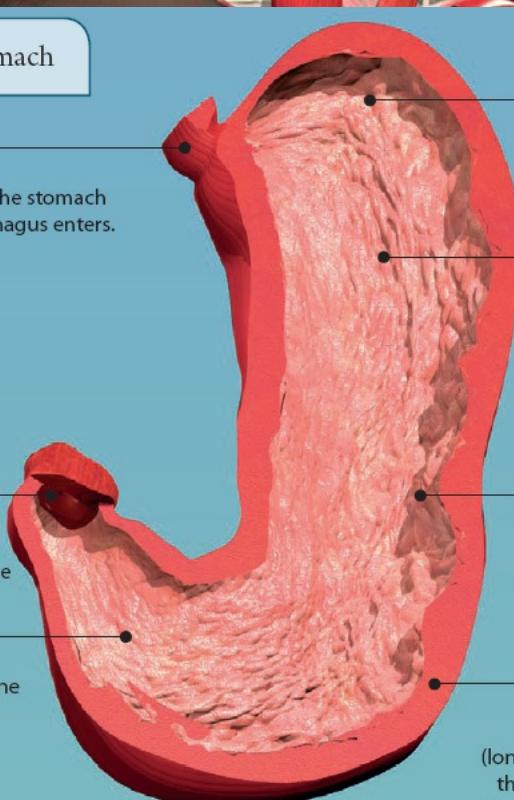
Internal Surface of Stomach

Lesser
is the ir
surface

Lesser
is a fold
that col
stomac

Cardia

is the region of the stomach
where the esophagus enters.



Esophagus
is a muscular tube that
delivers food to the stomach.

hragn

Fundus

is the upper dome-shaped
region of the stomach.

Body

is the main part
of the stomach.

omach

Pyloric sphincter

is a ring of muscle that varies
the size of the opening from the
stomach into the duodenum.

Pylorus

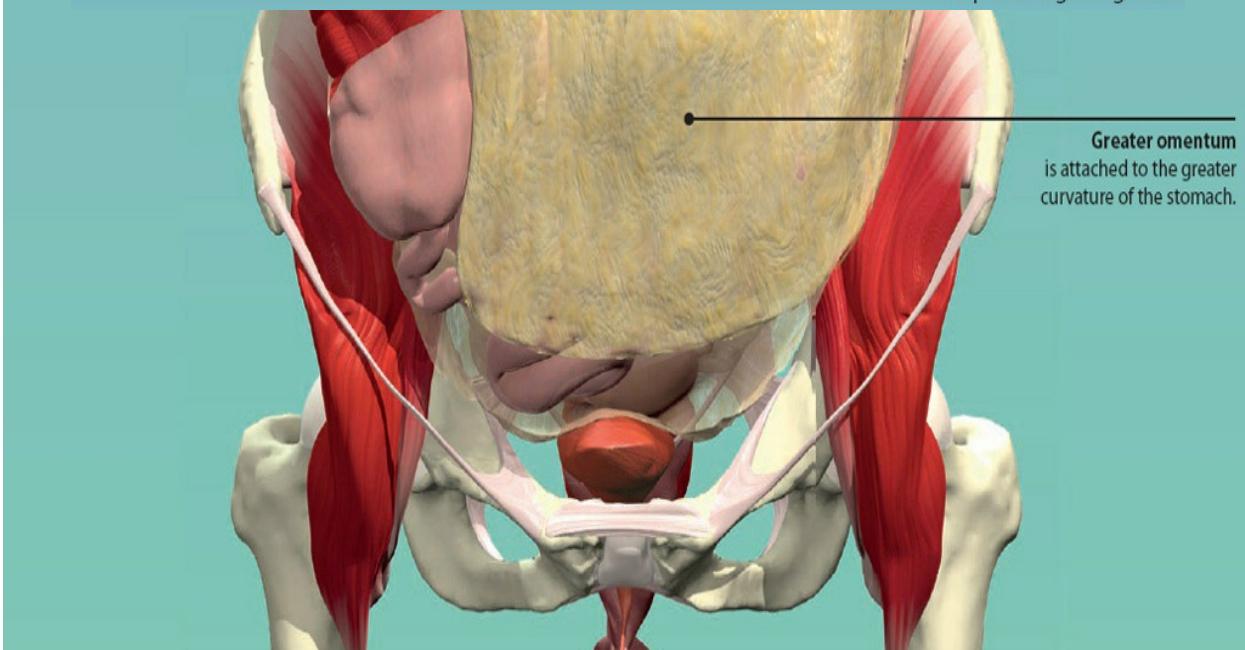
is the channel that directs chyme
towards the duodenum.

Rugae

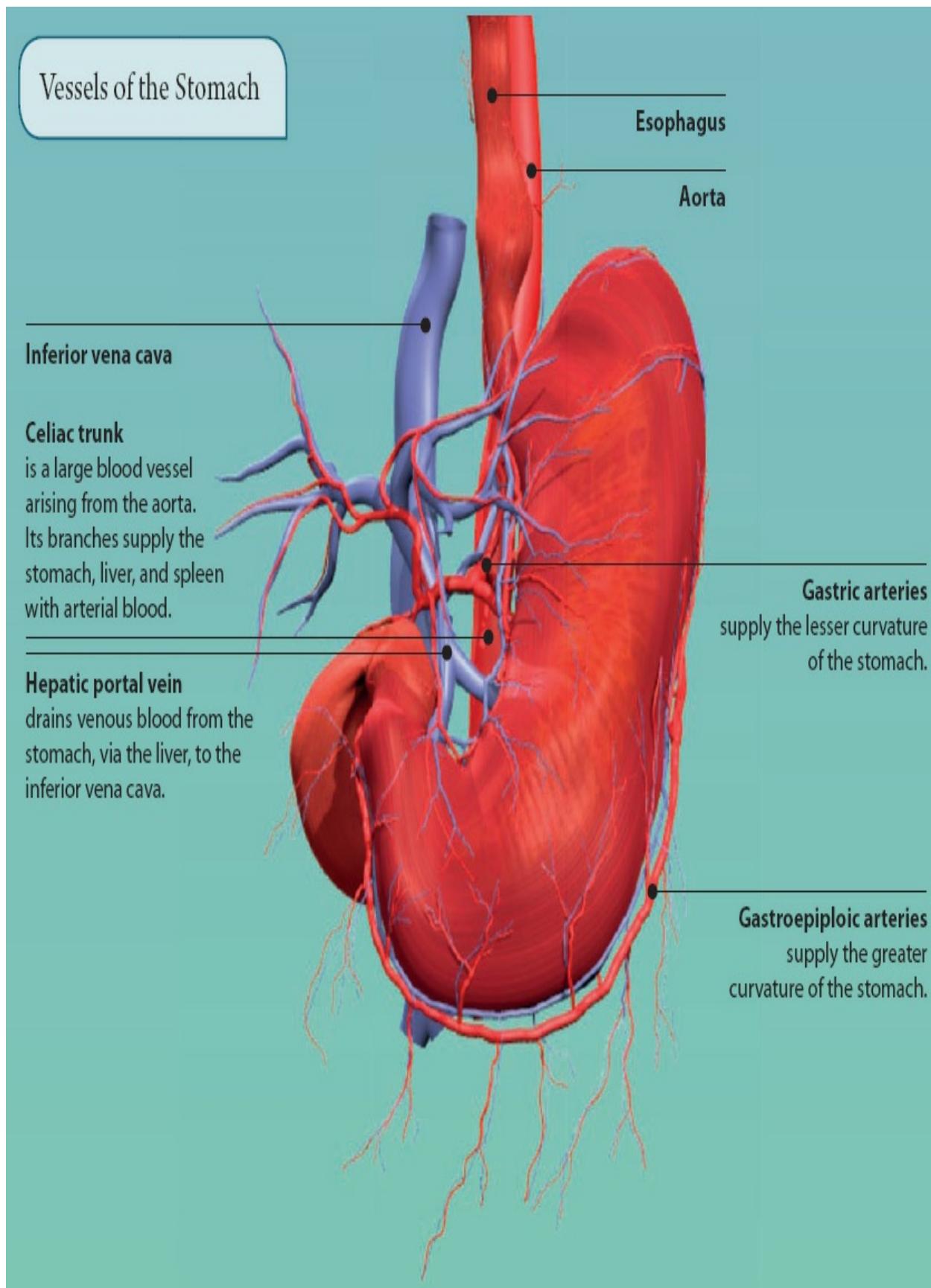
are folds in the stomach. They
allow the stomach to expand
and store food after a meal.

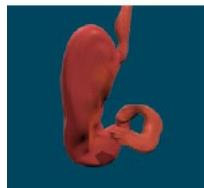
Stomach wall

has three muscle layers
(longitudinal, circular, and oblique)
that help mix the food. The lining
cells produce acid and enzymes that
help start digesting food.



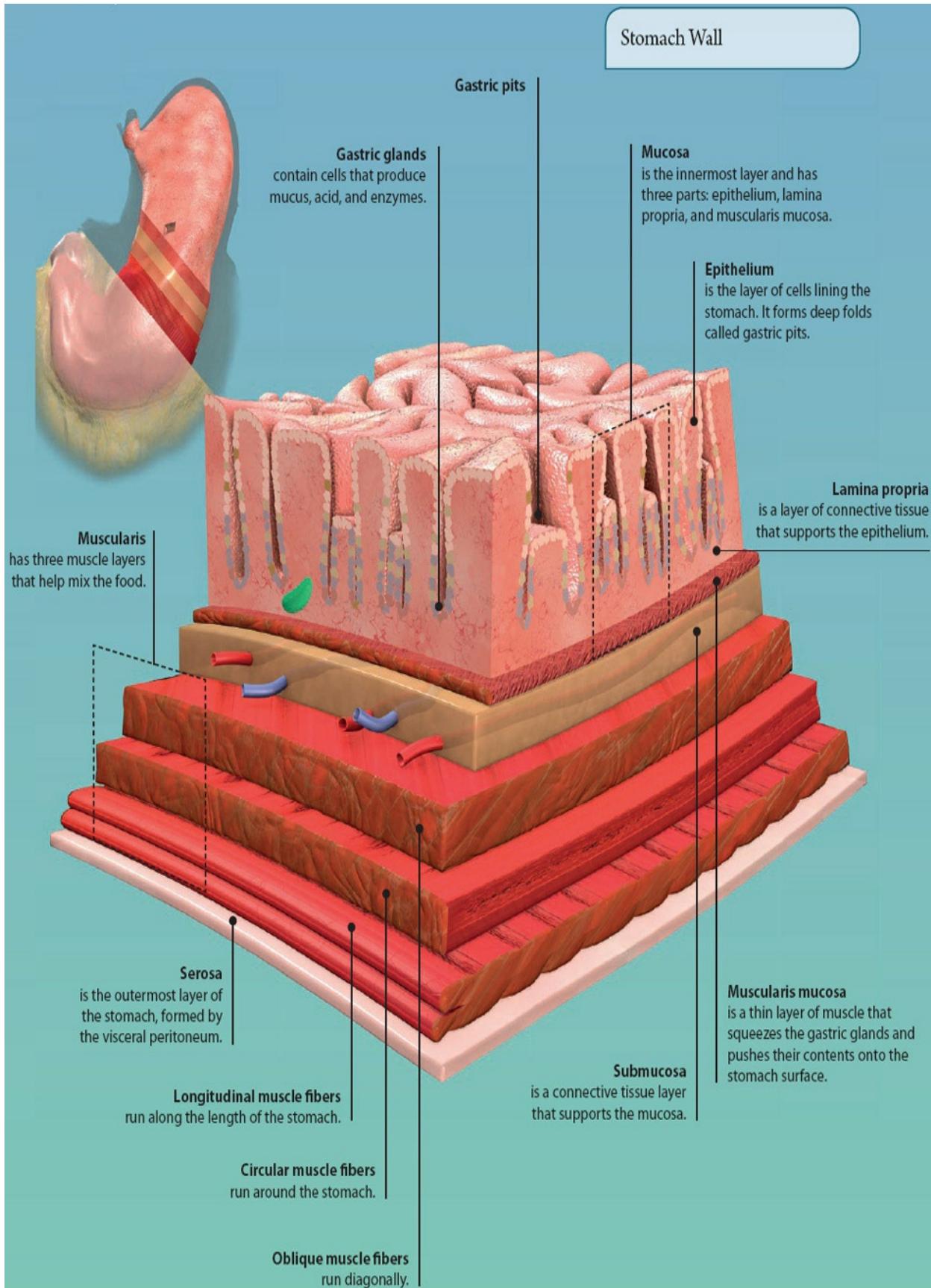
Greater omentum
is attached to the greater
curvature of the stomach.

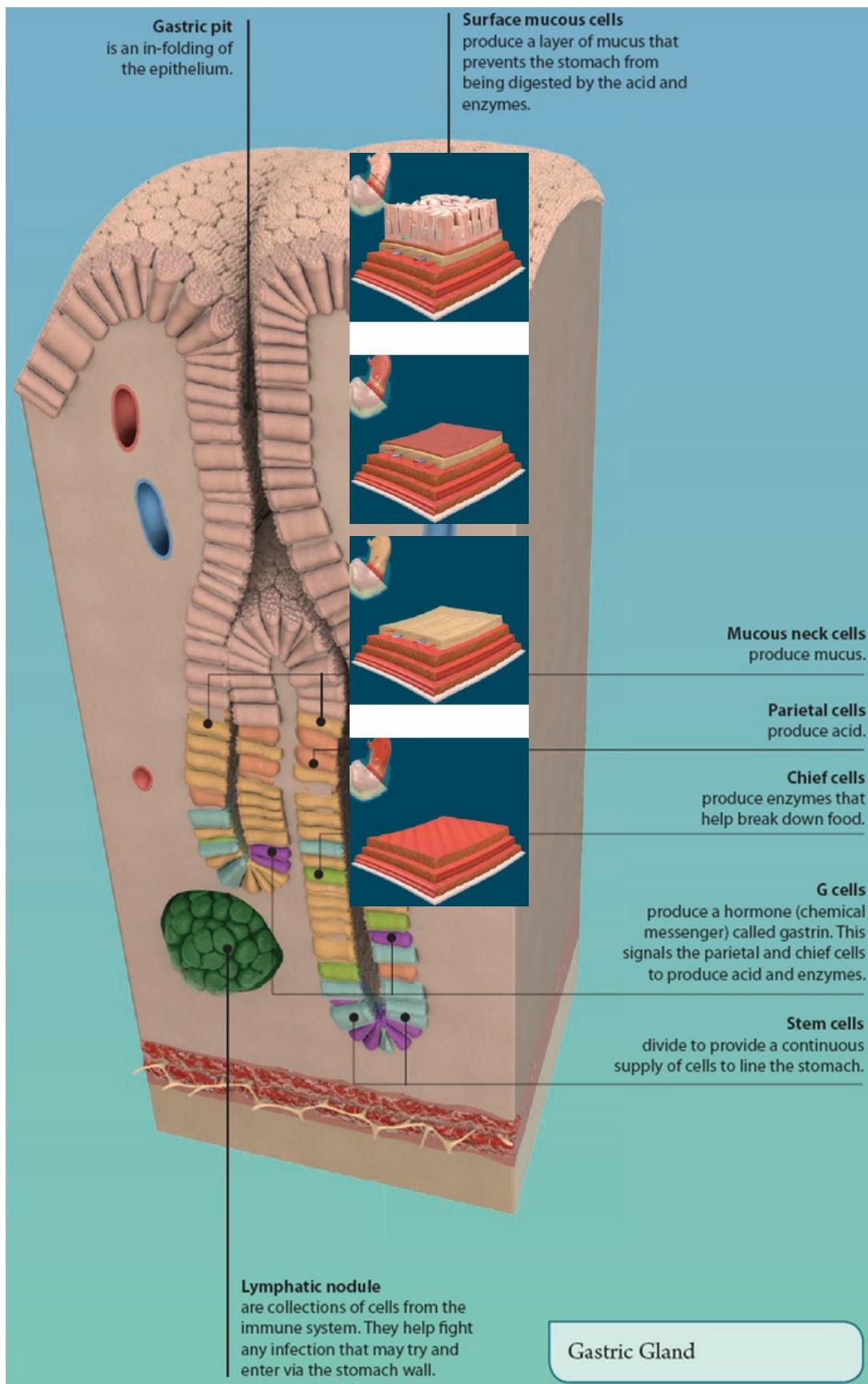


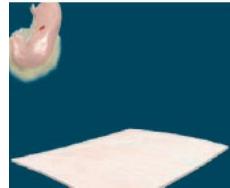
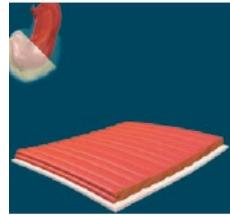
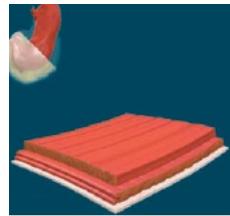


MICROANATOMY OF THE STOMACH WALL

The stomach wall contains specialized cells and tissues that help it to mix and digest food. It is made up of four layers: mucosa, submucosa, muscularis, and serosa.

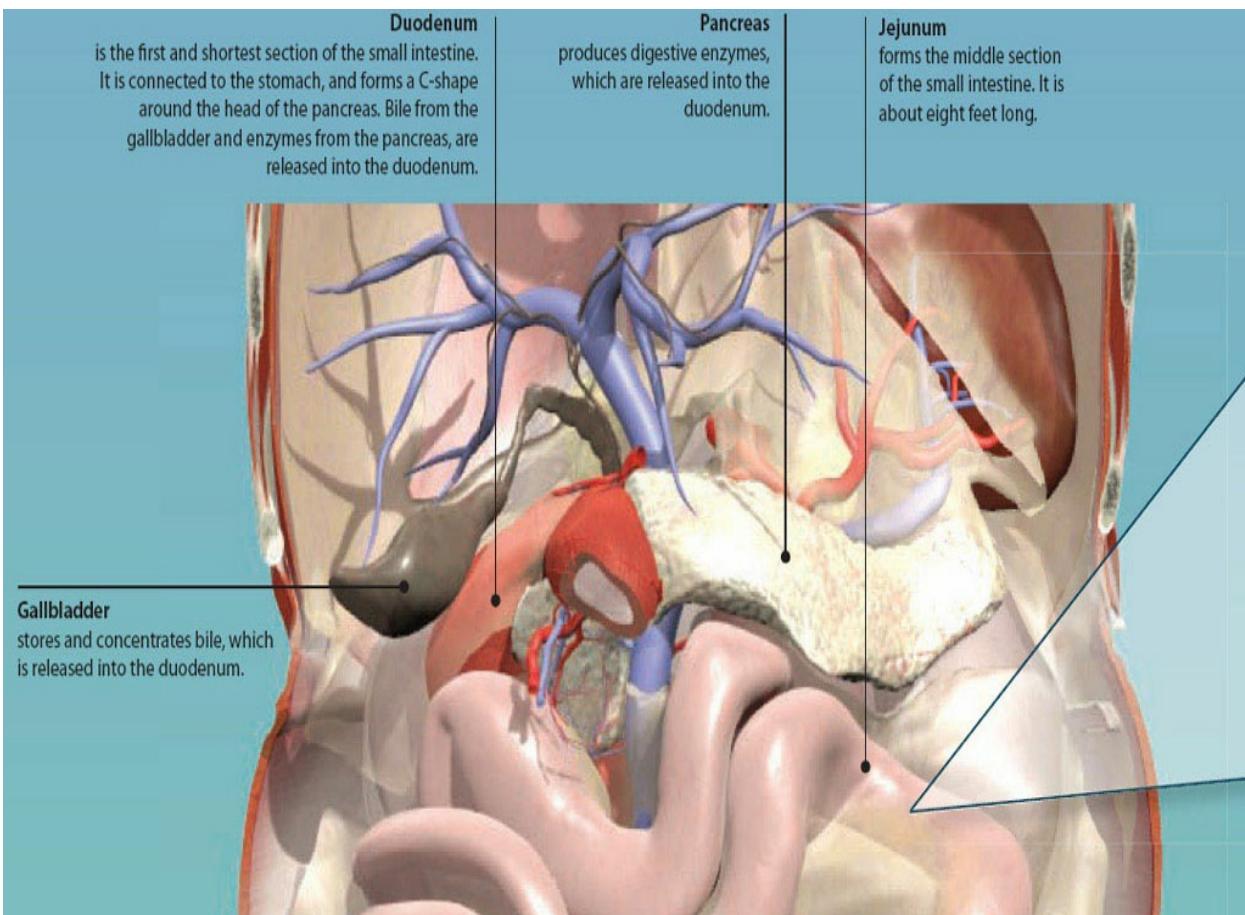






SMALL INTESTINE

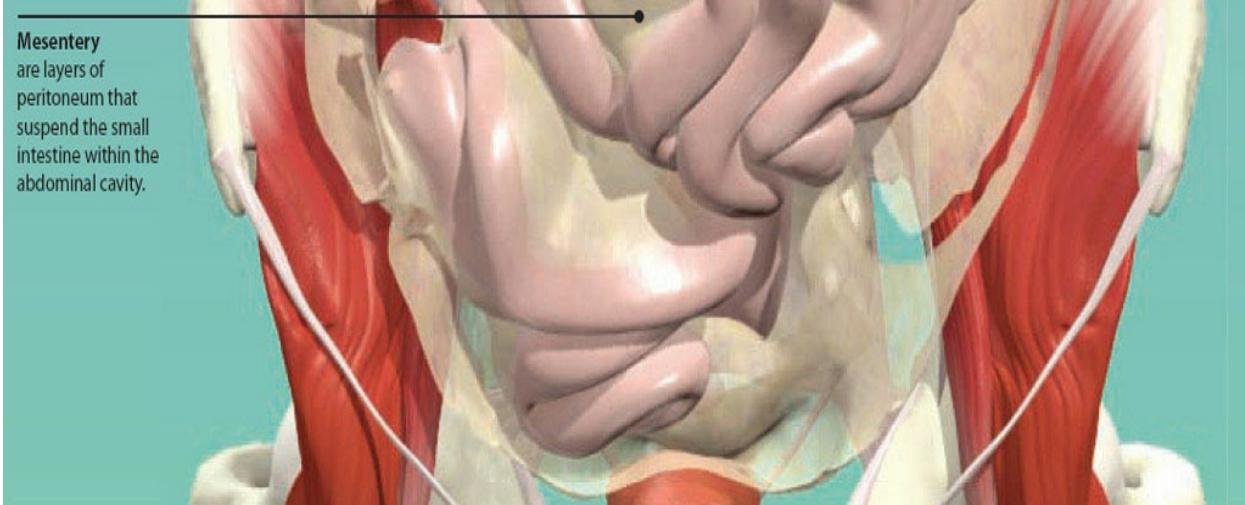
The small intestine is approximately twenty feet long. It is tightly coiled and lies within the abdominal cavity, connecting the stomach and large intestine. It is divided into three sections: duodenum, jejunum, and ileum.

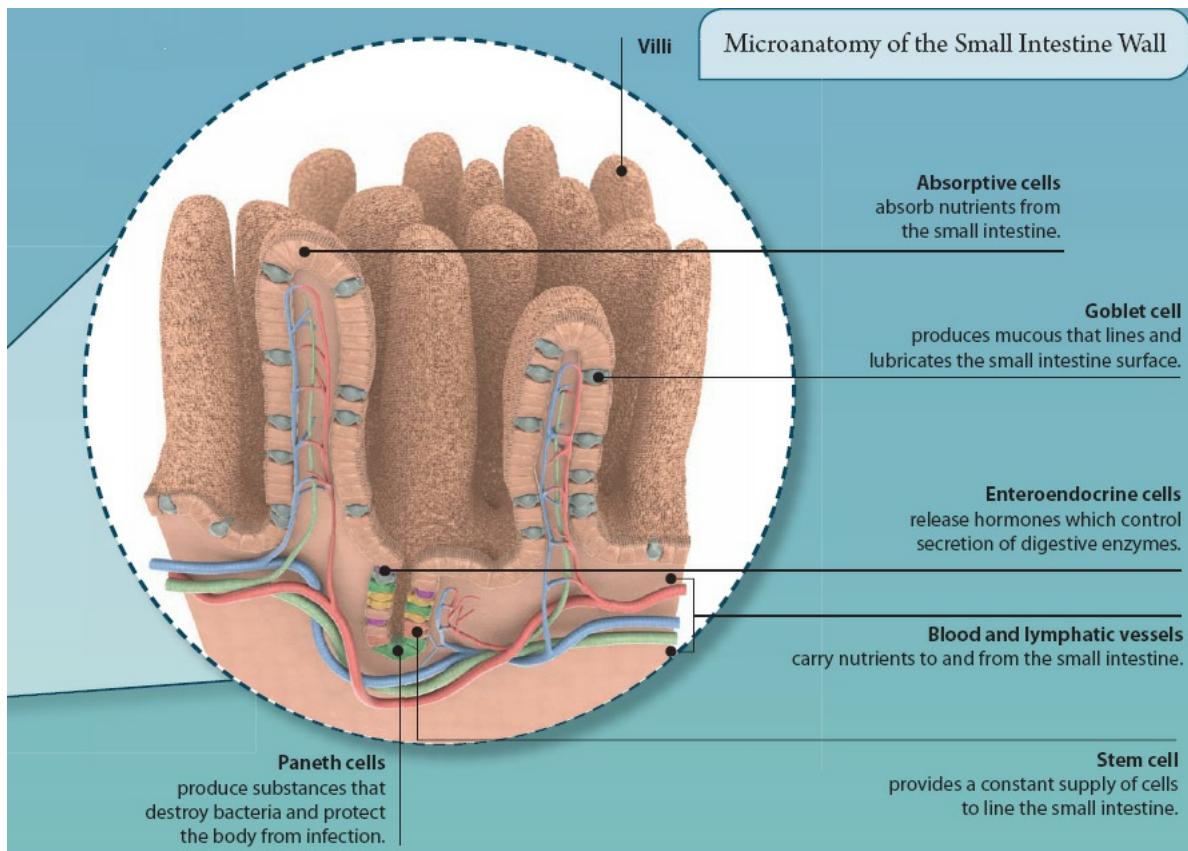


MICROANATOMY OF THE SMALL INTESTINE

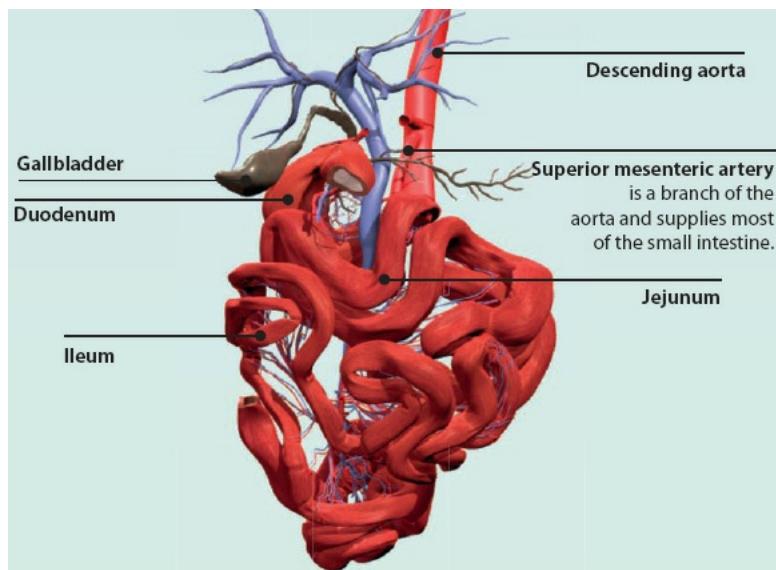
Ileum

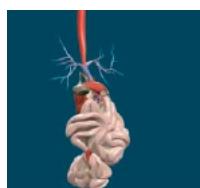
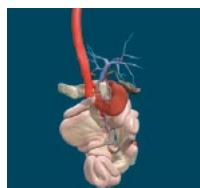
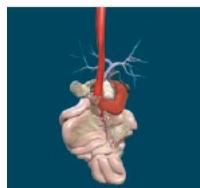
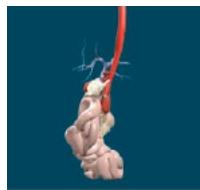
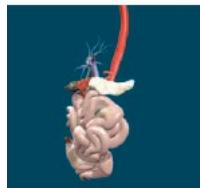
The **main roles** of the small intestine are digestion (breaking food down into small nutrients) and absorption (taking them **into the body**). The lining of the small intestine has fingerlike projections called villi, which massively increase the surface area available for absorption. **about 12 feet long.**





Vessels of the Small Intestine





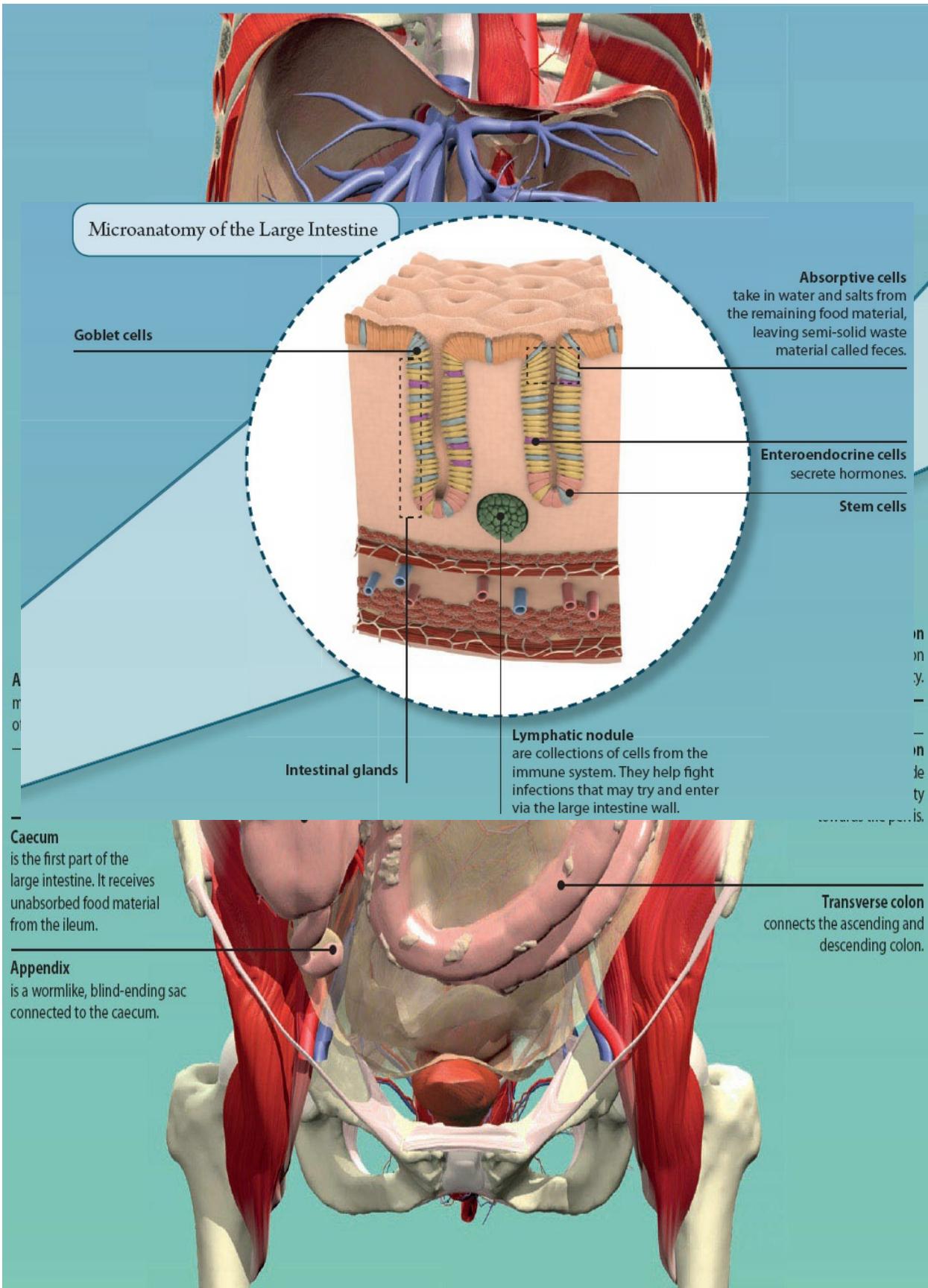
LARGE INTESTINE

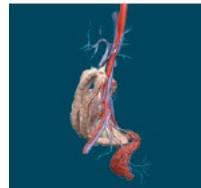
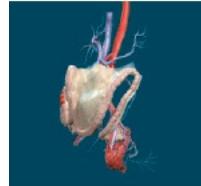
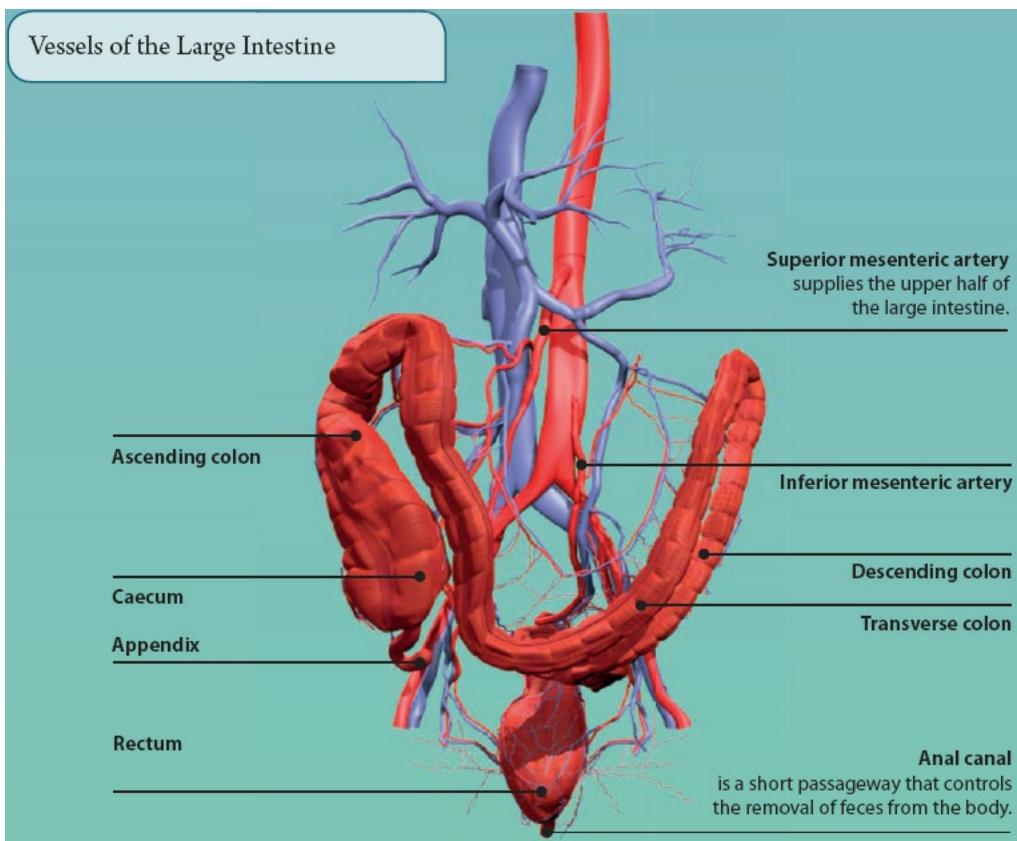
The large intestine is a wide, muscular tube that is about five feet long. It runs from the ileum of the small intestine to the anal canal.

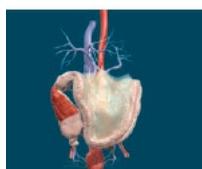
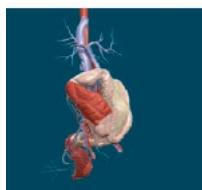
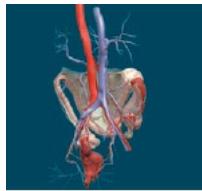
The main functions of the large intestine are the absorption of water and salts from the remaining food, and the formation of waste material. This is removed from the body in a process called defecation.

Did you know?

The normal large intestine contains trillions of bacteria. They help break down any remaining nutrients, and by doing this produce gas (flatus), as well giving feces their distinctive odor and color.





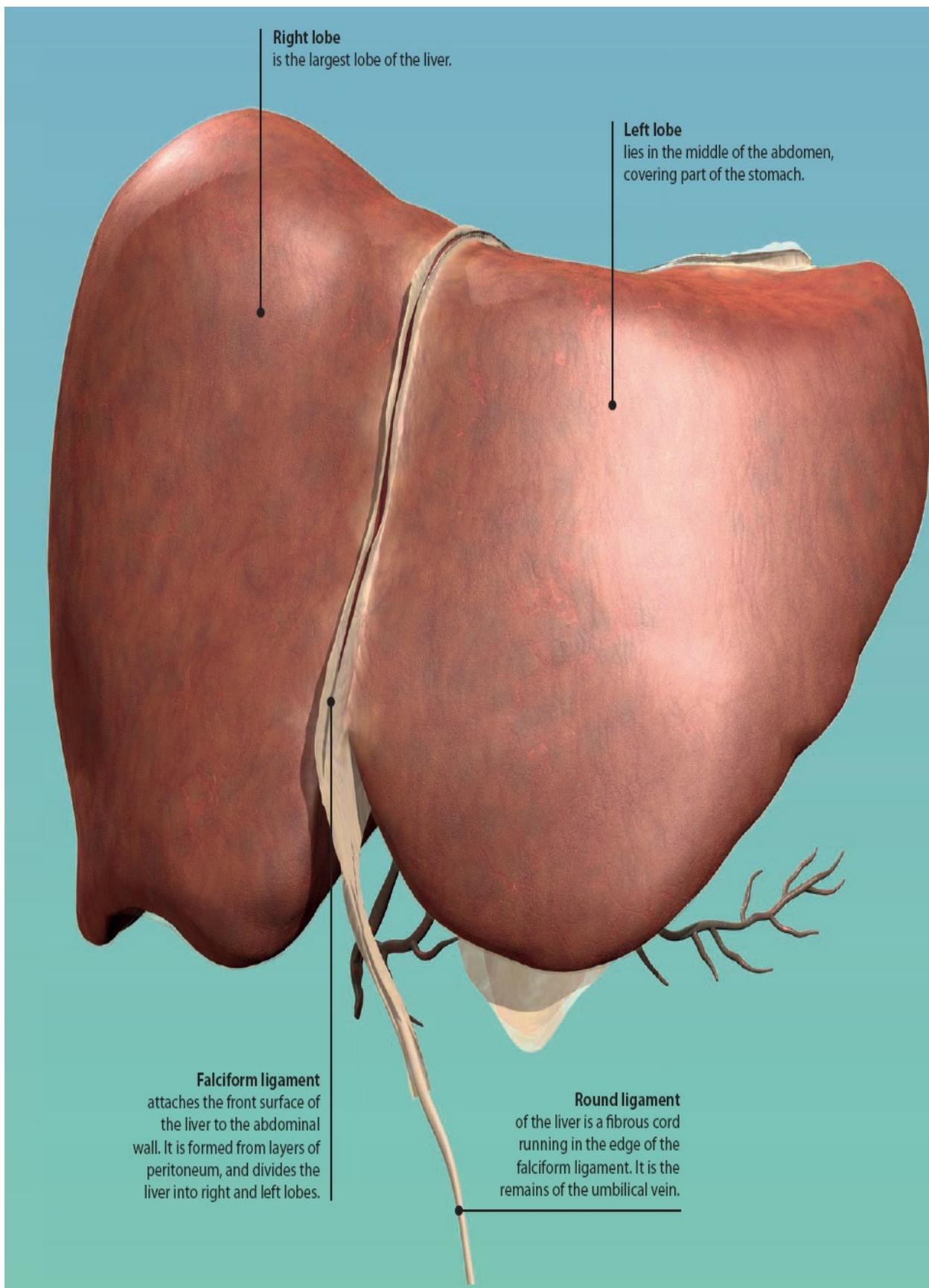


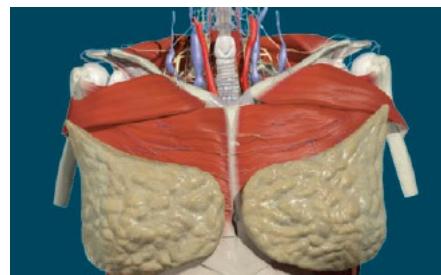
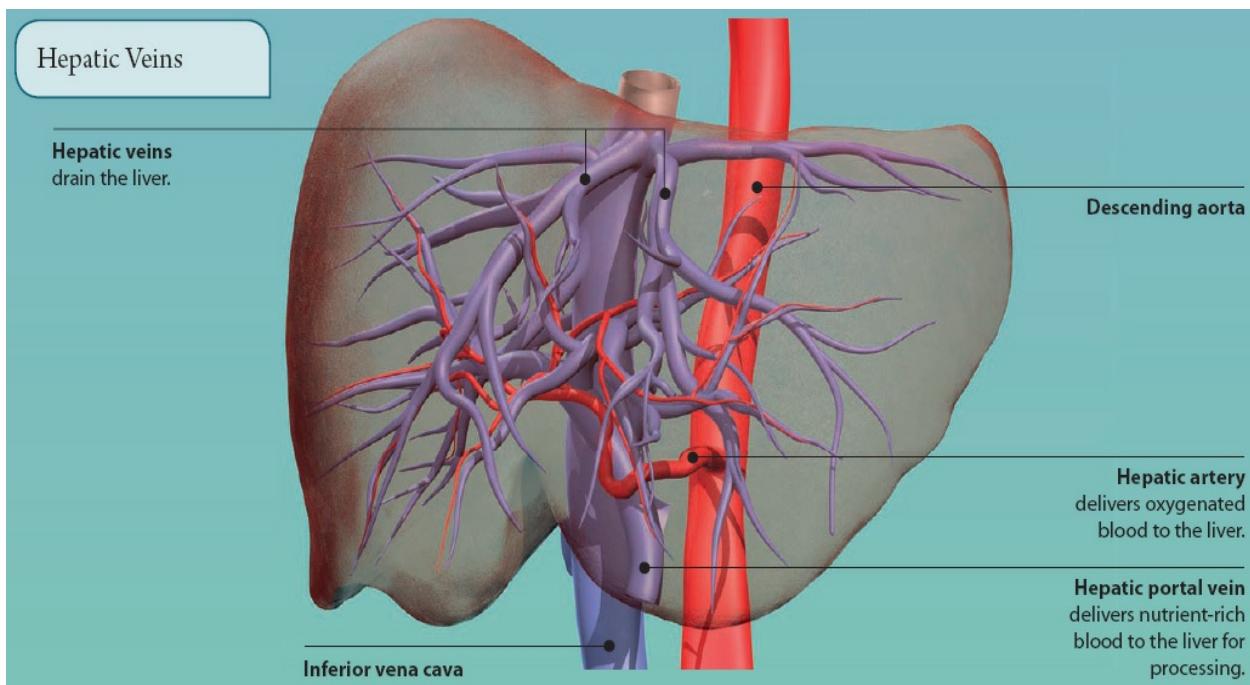
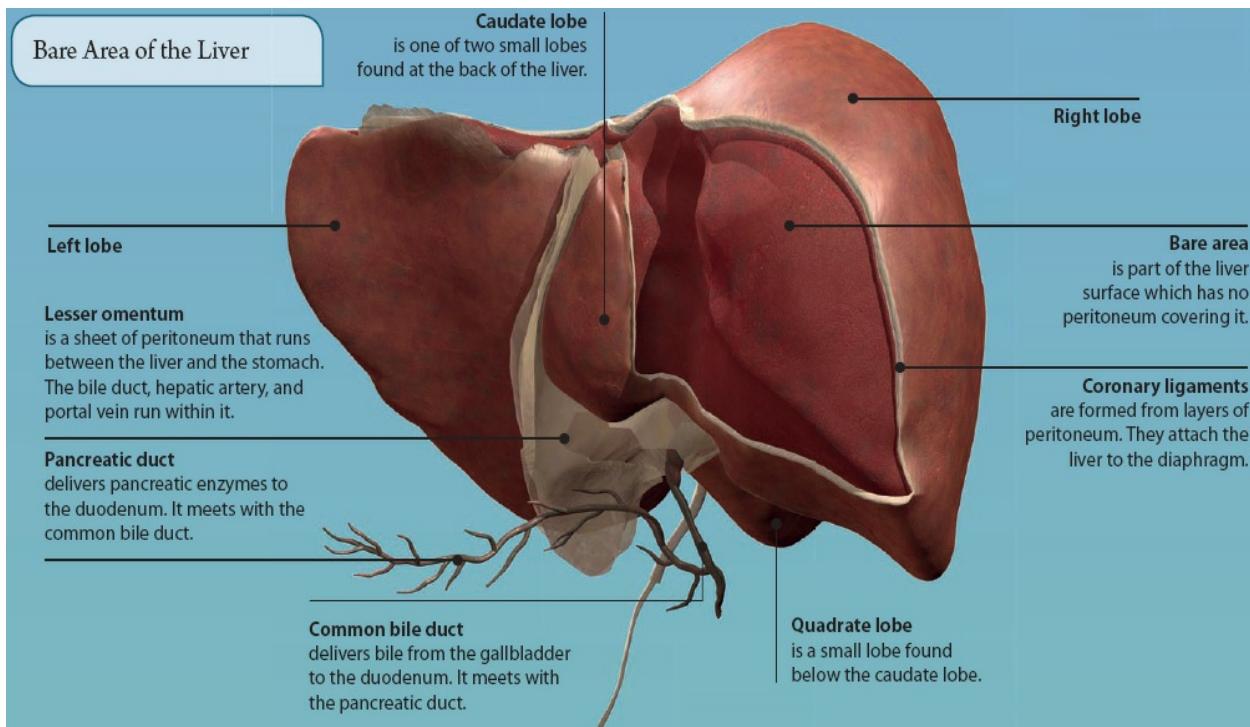
LIVER

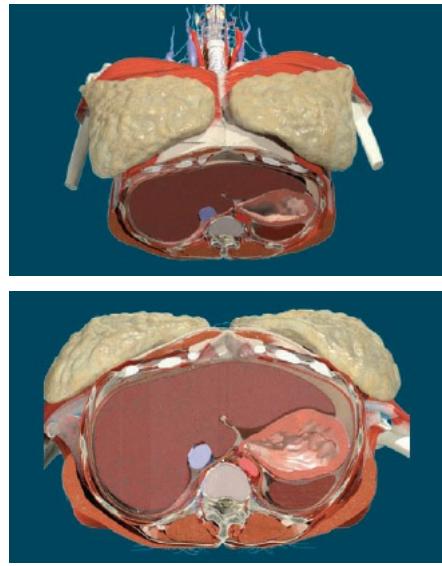
The liver is the largest internal organ in the body. It is located directly beneath the diaphragm, on the right side of the abdomen.

The liver has many important functions. These include processing nutrients absorbed from the small intestine, storage of some vitamins and minerals, producing bile and plasma proteins, and removing poisons from the blood.

The liver has two blood vessels supplying it: the hepatic portal vein and the hepatic artery.



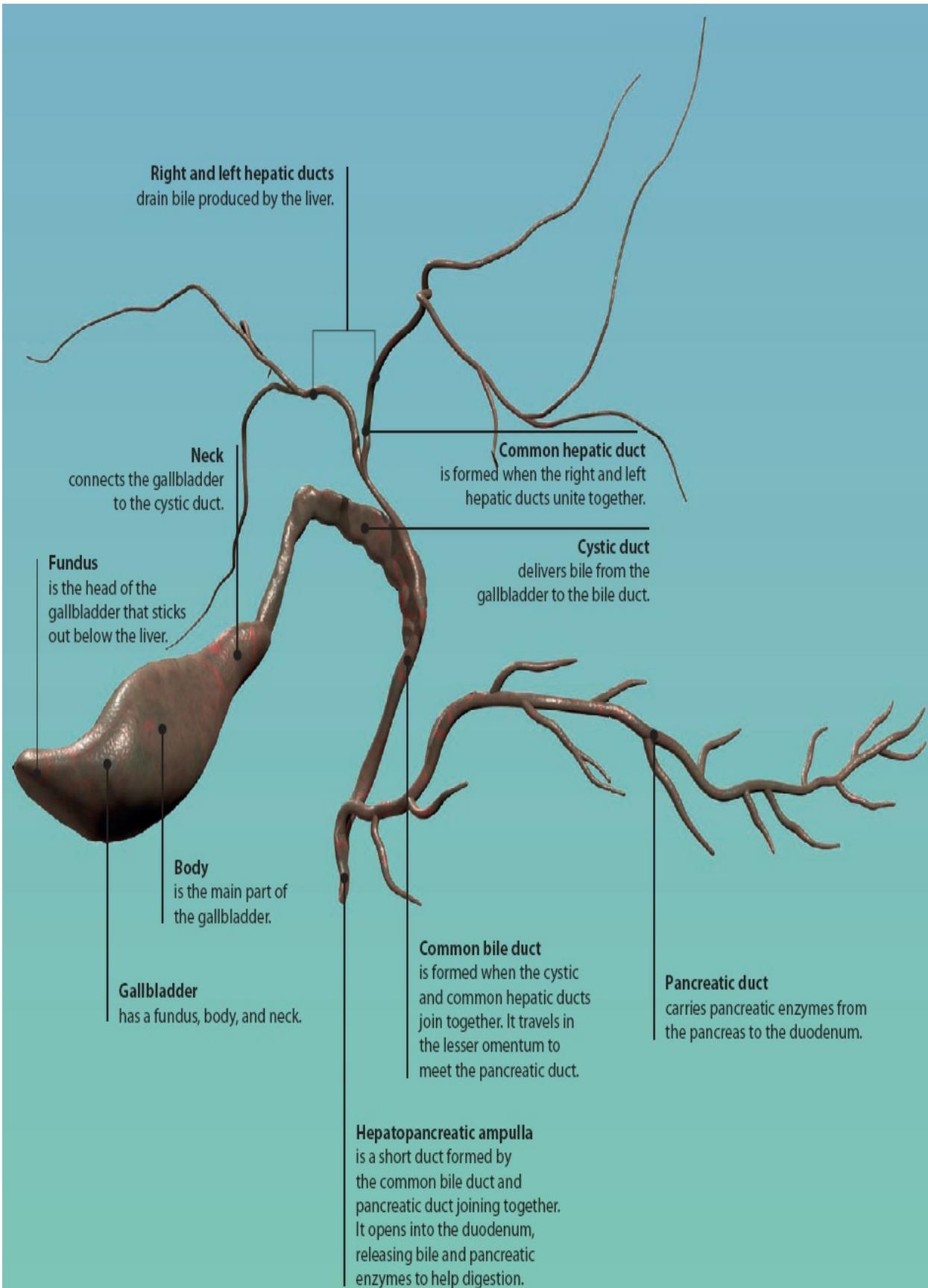


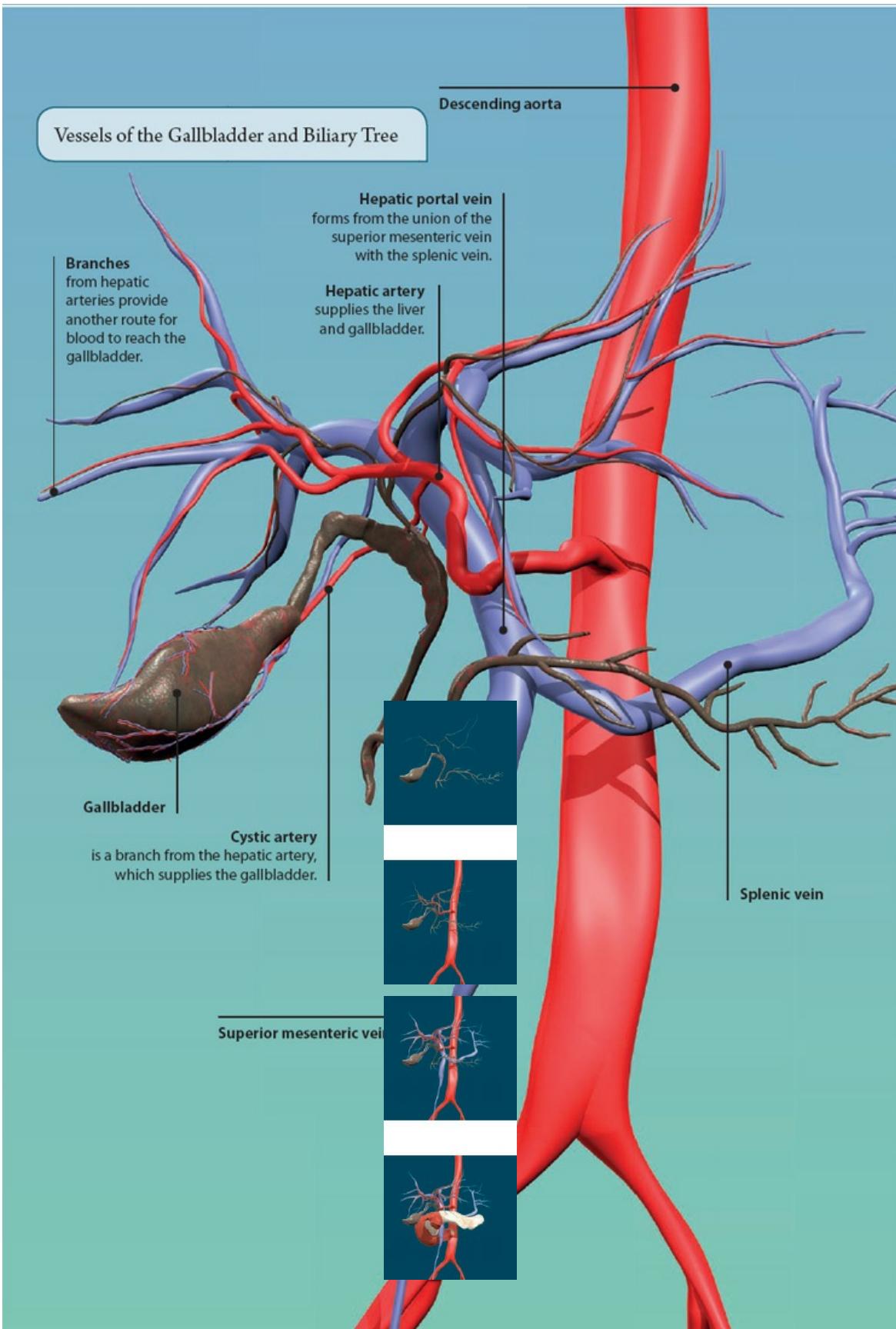


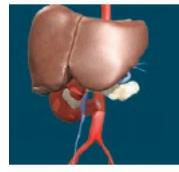
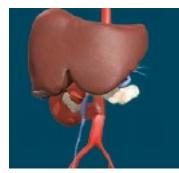
GALLBLADDER AND BILIARY TREE

The gallbladder is a small saclike organ found in the right side of the upper abdomen, behind the liver. It stores and concentrates bile. After a fatty meal, the gallbladder squirts bile along the biliary tree and into the small intestine to aid digestion.

Bile is a green liquid produced in the liver. It helps to split up fats and oils so that they can be more easily digested. The biliary tree consists of the ducts, which connect the liver, gallbladder, and pancreas to the duodenum, where bile is released.



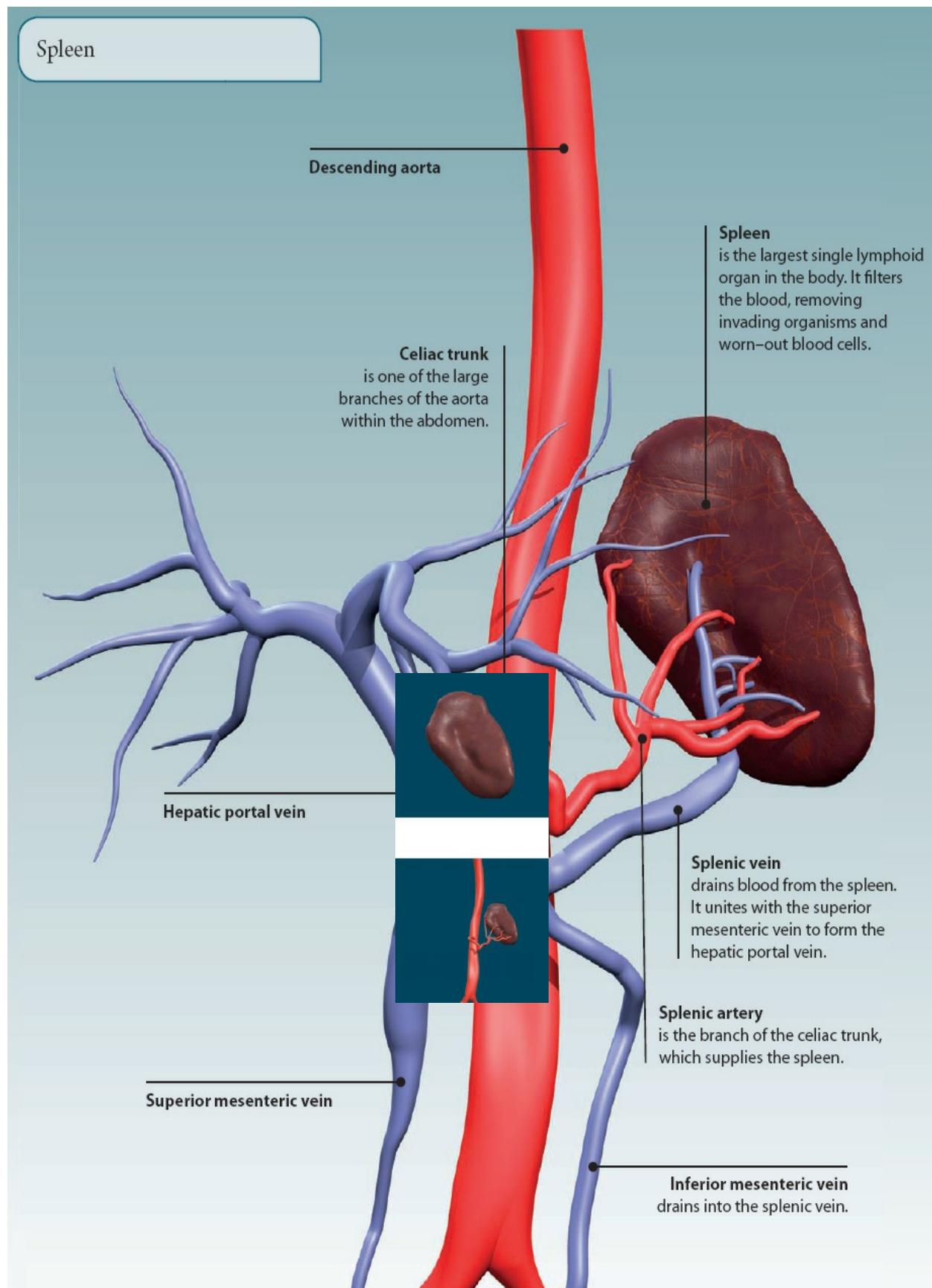


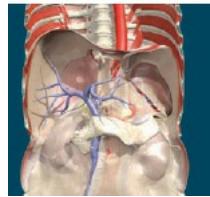
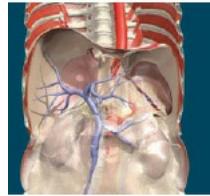
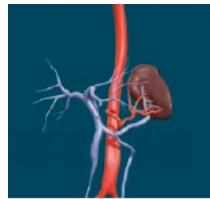


PANCREAS AND SPLEEN

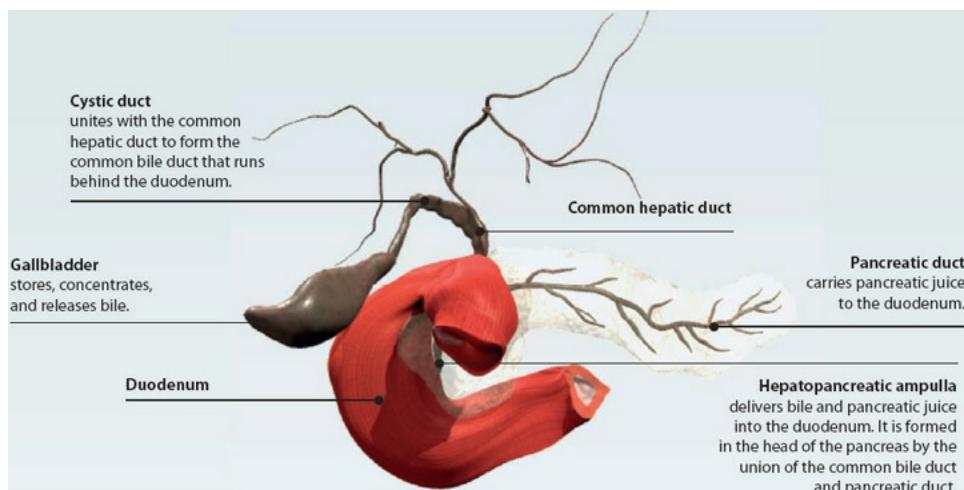
The pancreas is a long, thin organ that lies horizontally along the back wall of the upper abdomen behind the stomach. It produces enzyme-rich pancreatic juice, which is released into the duodenum to help digestion. The pancreas also produces the hormones insulin and glucagon, which help control blood sugar levels.

The spleen is an oval-shaped organ, and is part of the lymphatic system. It lies on the upper left side of the abdomen, between the stomach and the diaphragm. It contains large numbers of white blood cells and filters the blood.

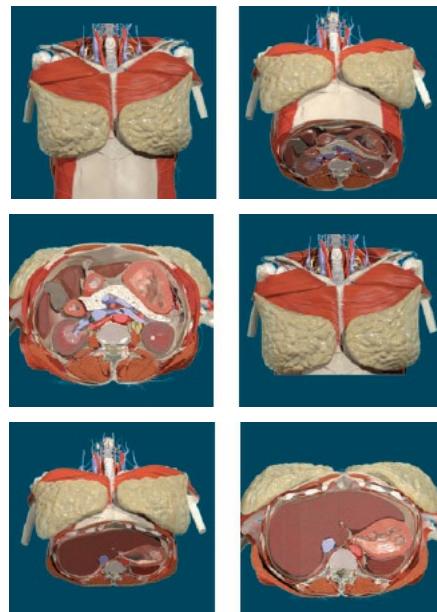
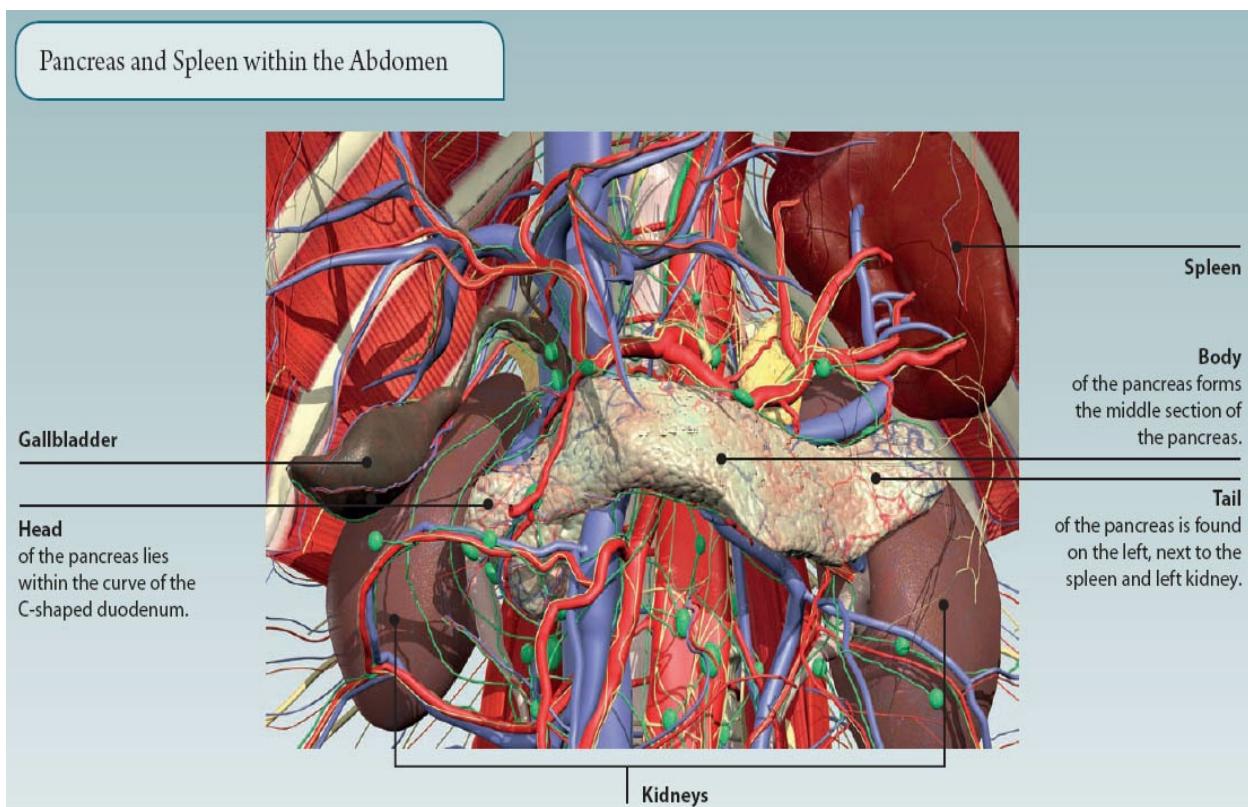




Pancreas, Duodenum, and Pancreatic Duct



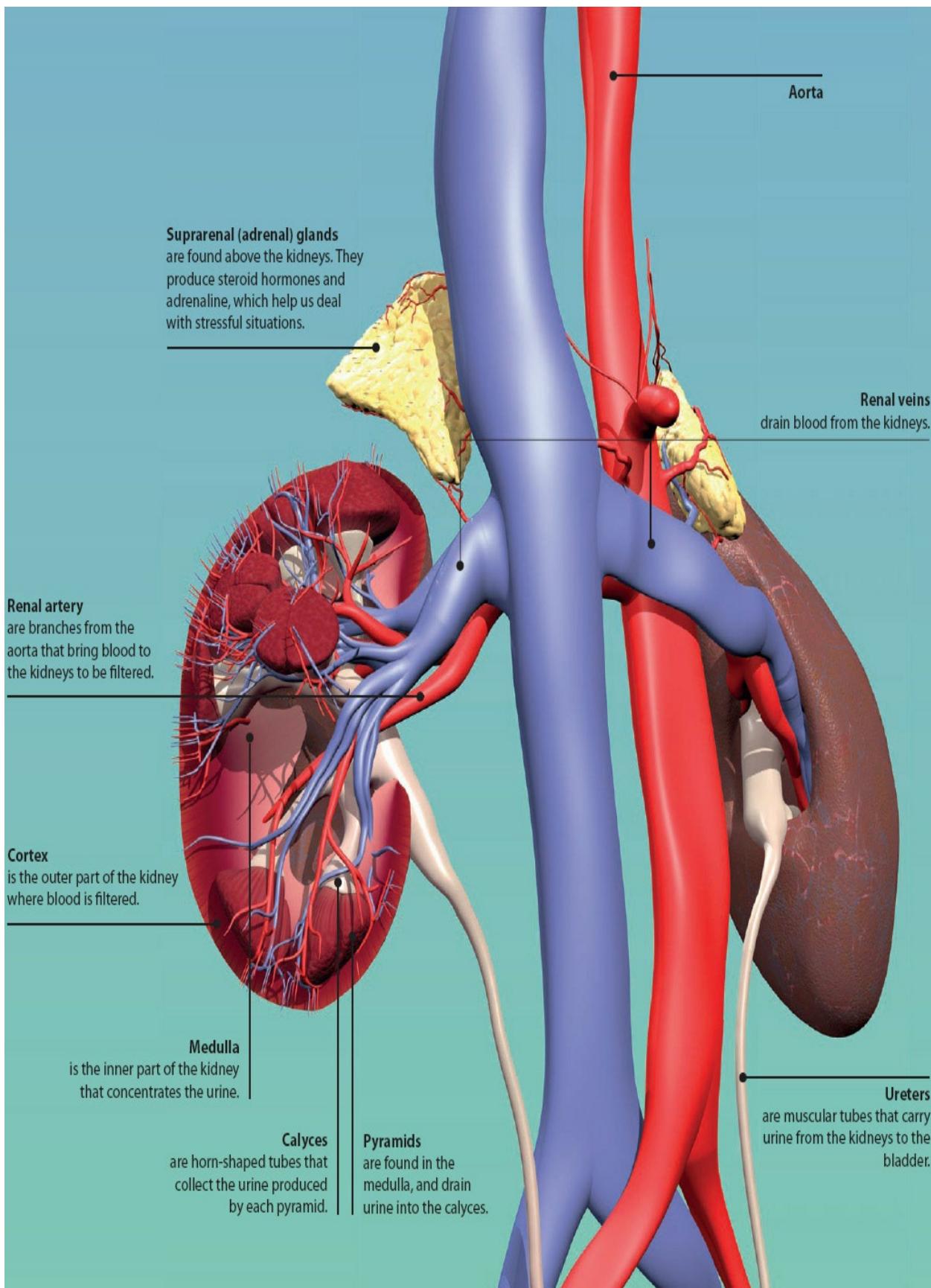
Pancreas and Spleen within the Abdomen



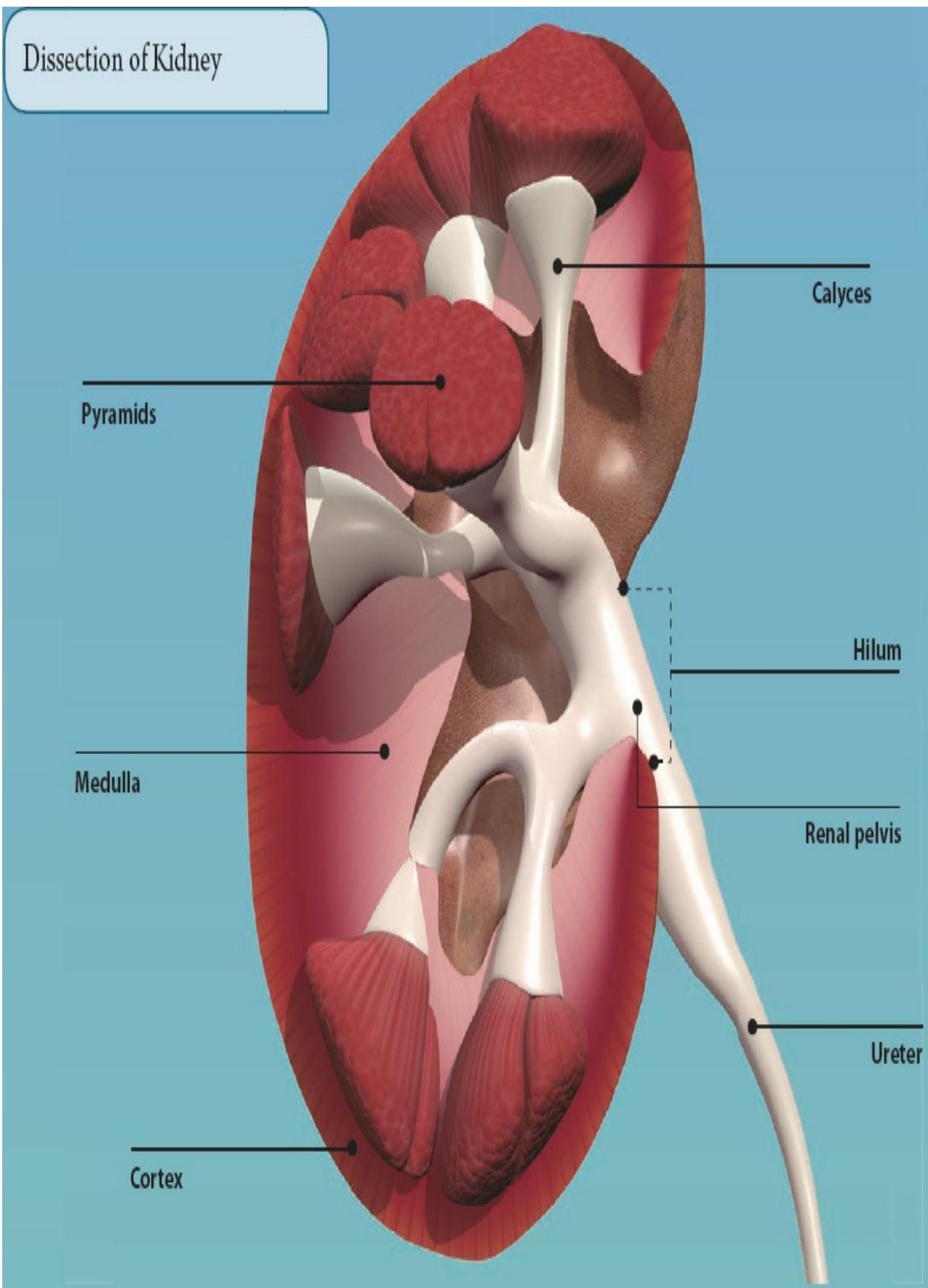
KIDNEY

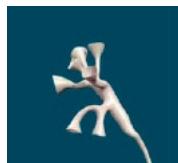
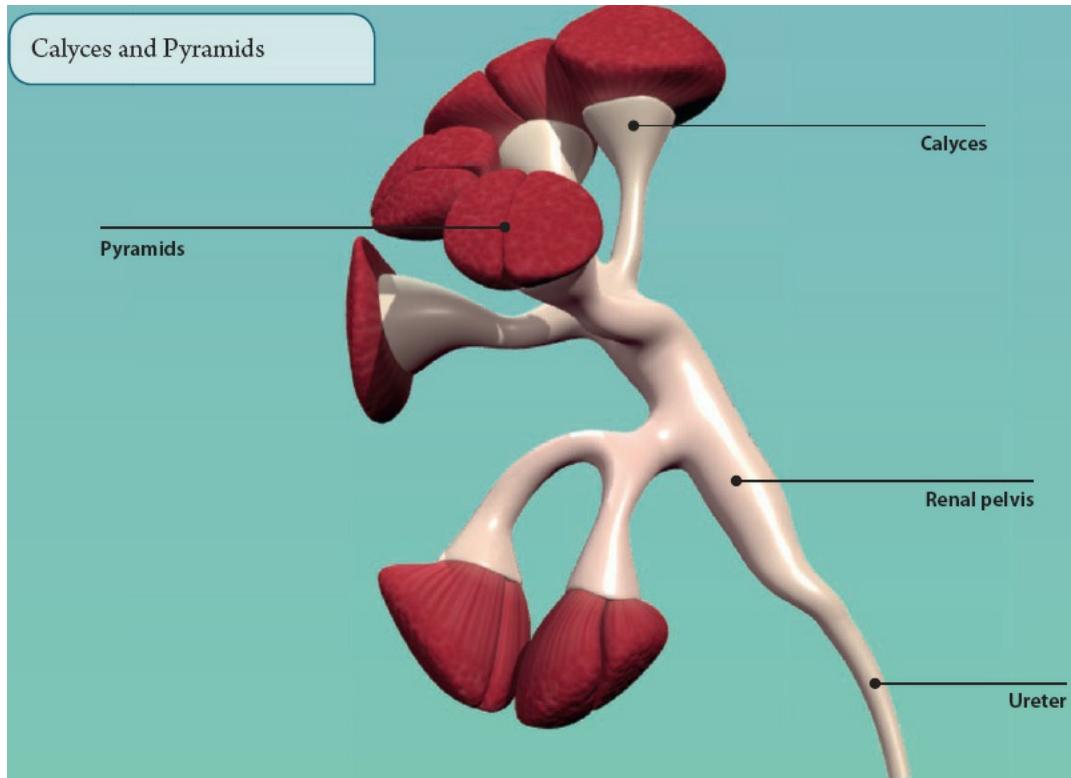
The kidneys are two bean-shaped organs, found on either side of the spine. They lie behind the peritoneum (retroperitoneal), high up on the back wall of the abdomen.

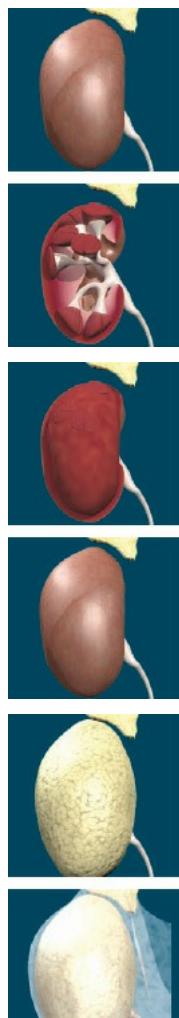
The kidneys filter the blood of impurities, forming a waste product called urine. They control the amount of water and salts in the body, as well as producing hormones that control blood pressure, red blood cell production, and calcium levels.



Dissection of Kidney

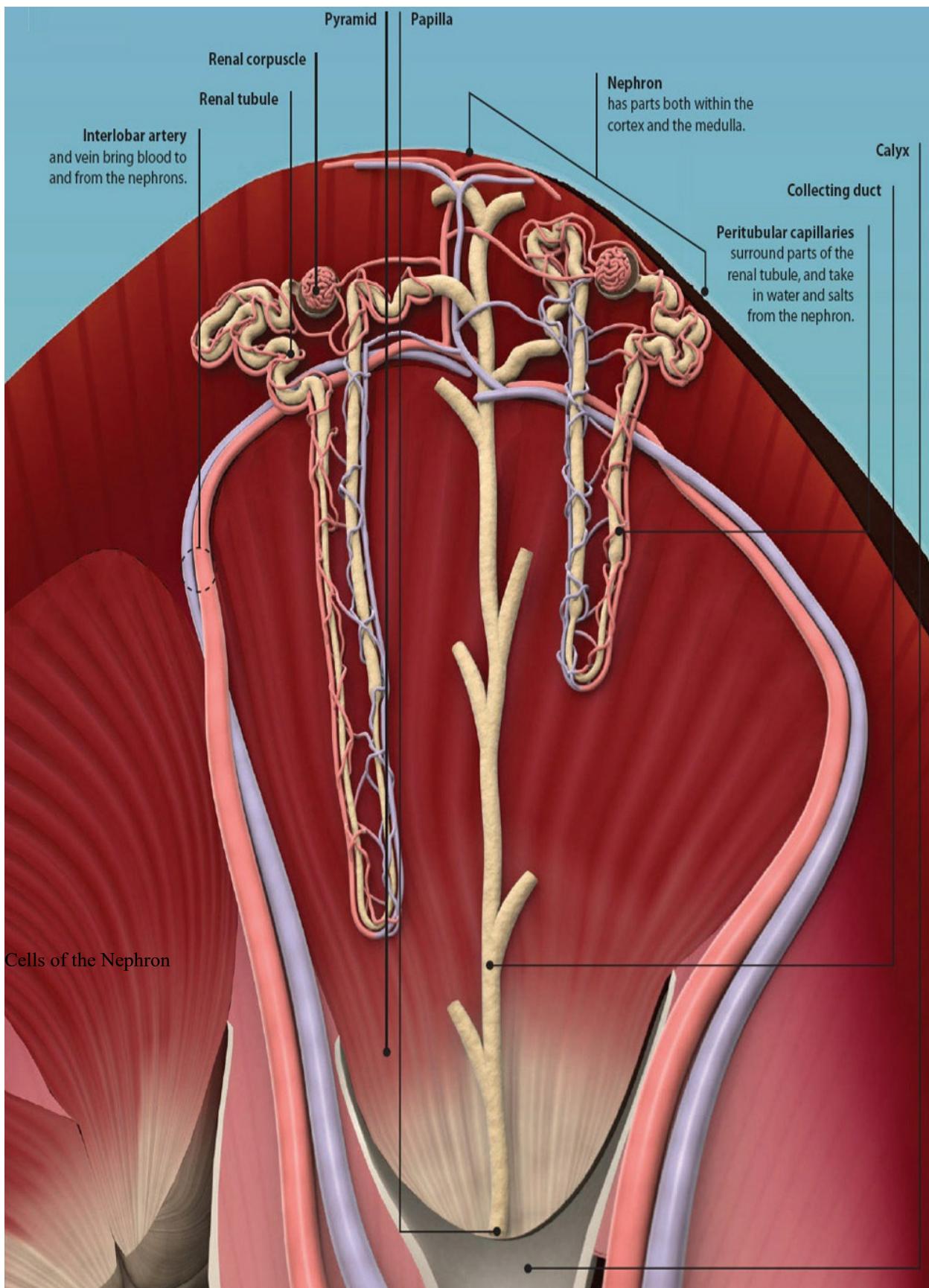


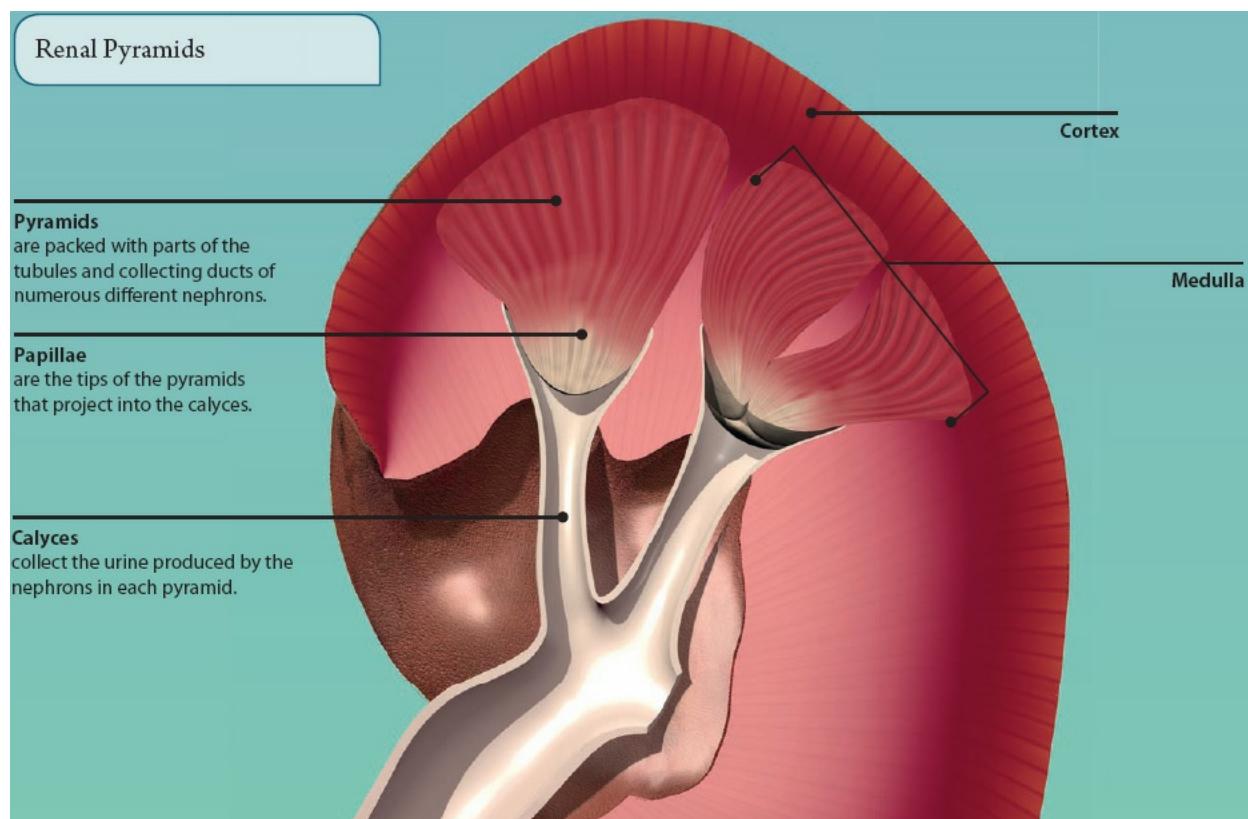
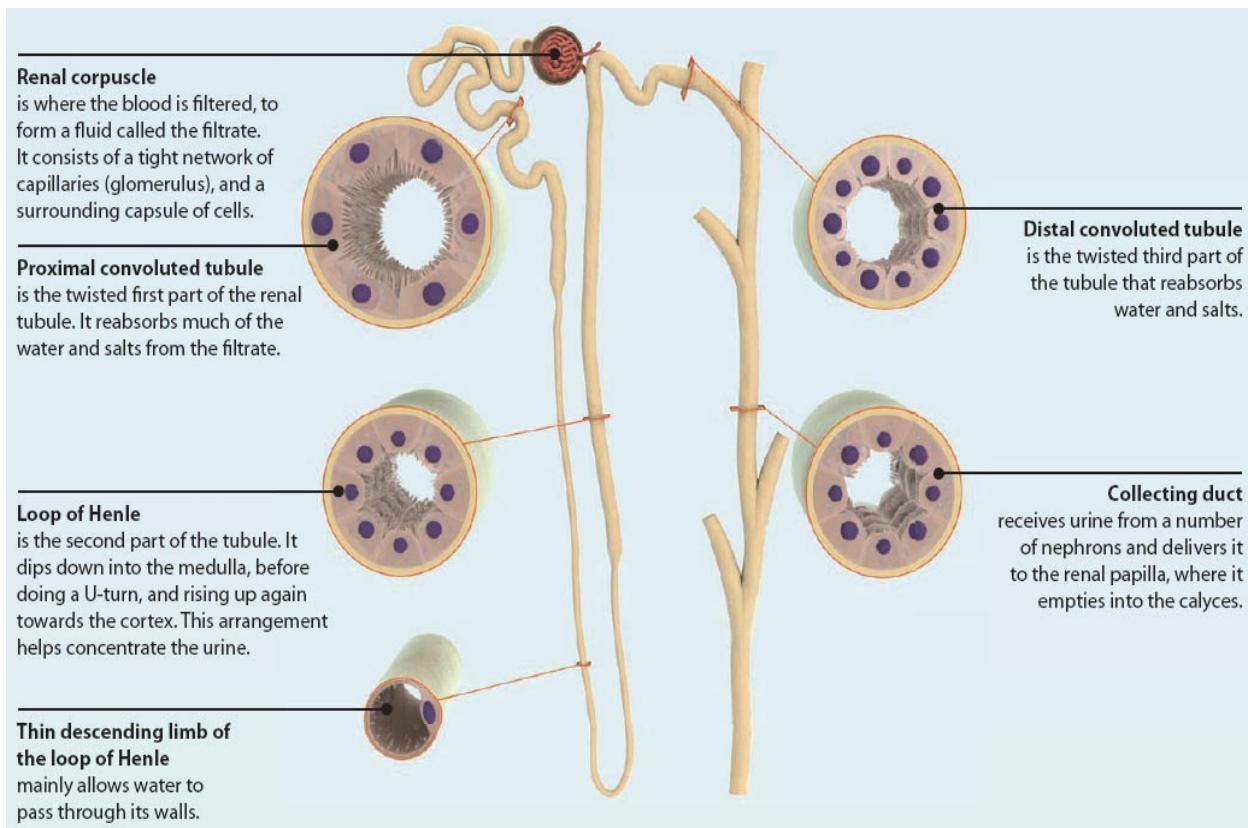




NEPHRON

Each kidney contains about a million nephrons. These are the working units of the kidney, which filter the blood and process the fluid, eventually forming urine. This drains into the calyces at the tip of the pyramids. Each nephron consists of a renal corpuscle, a renal tubule, and a collecting duct.

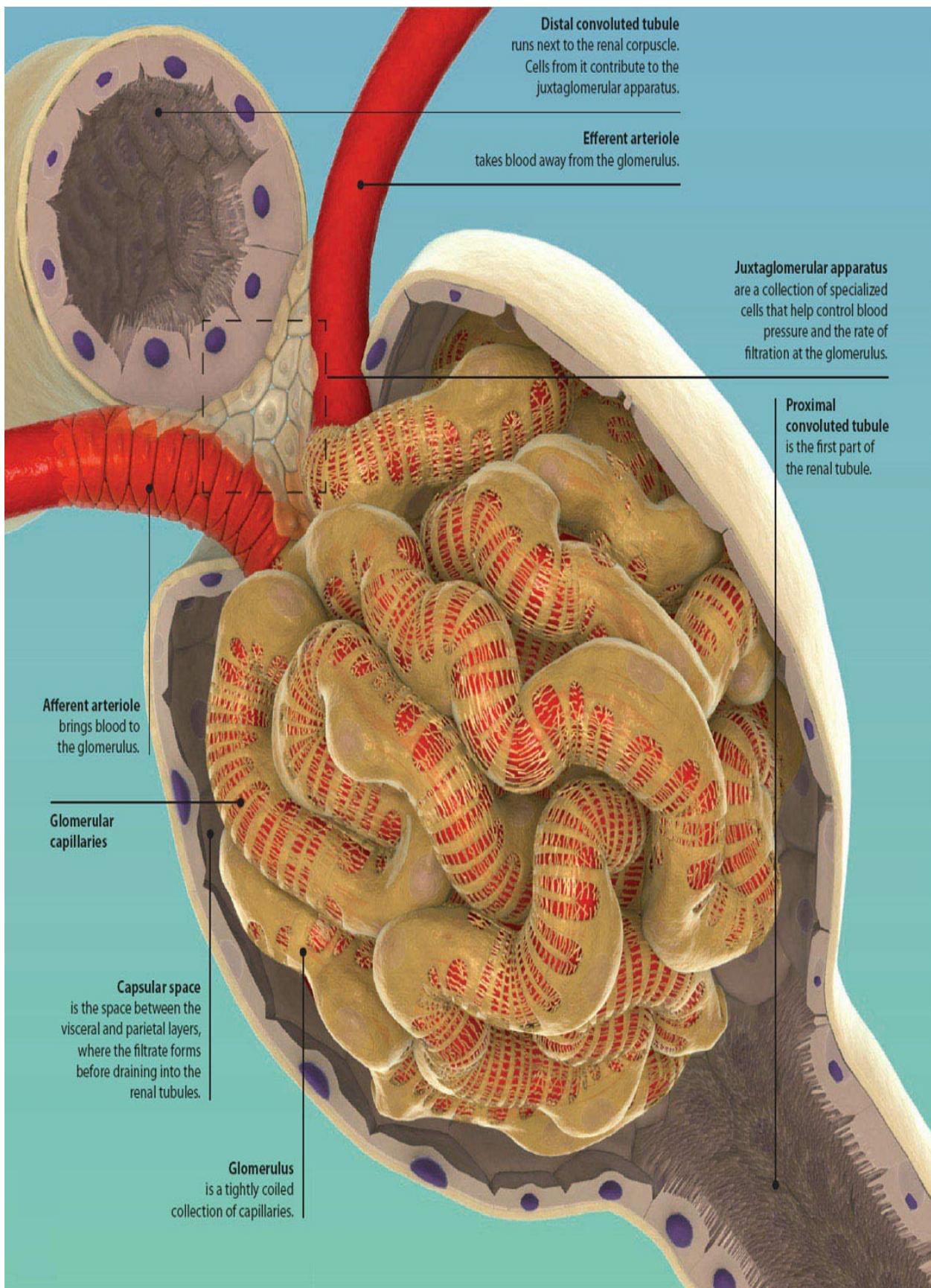


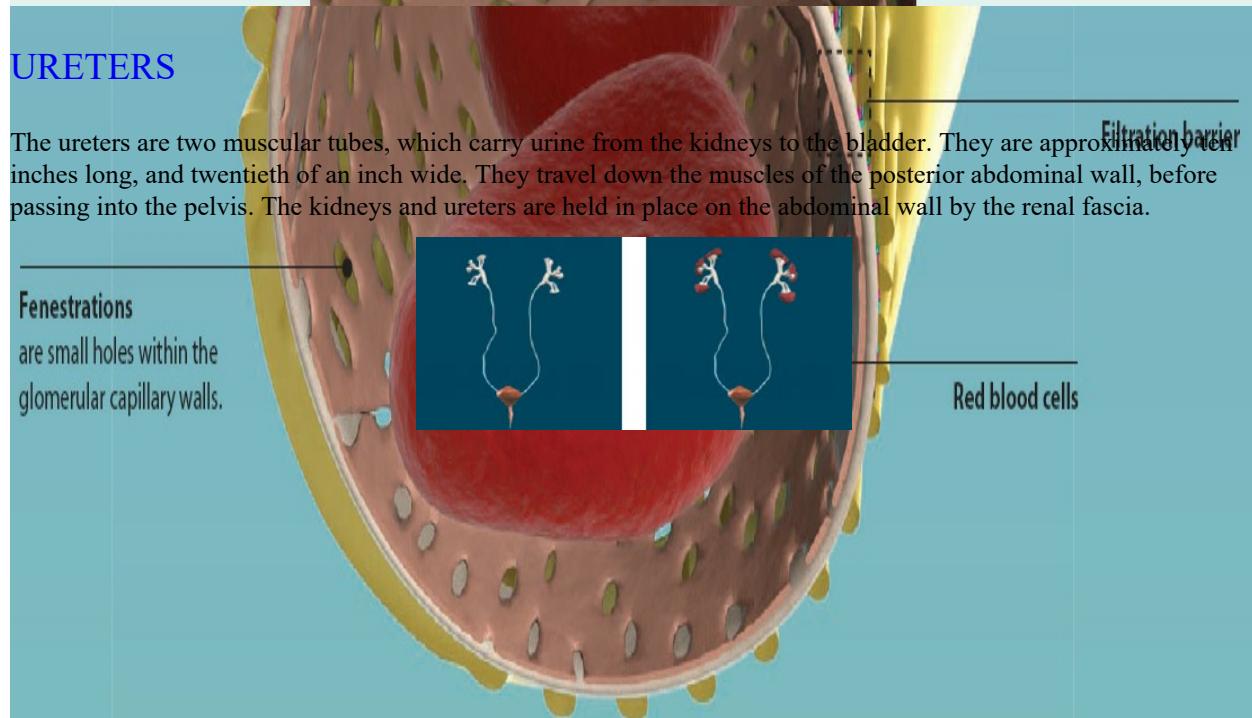
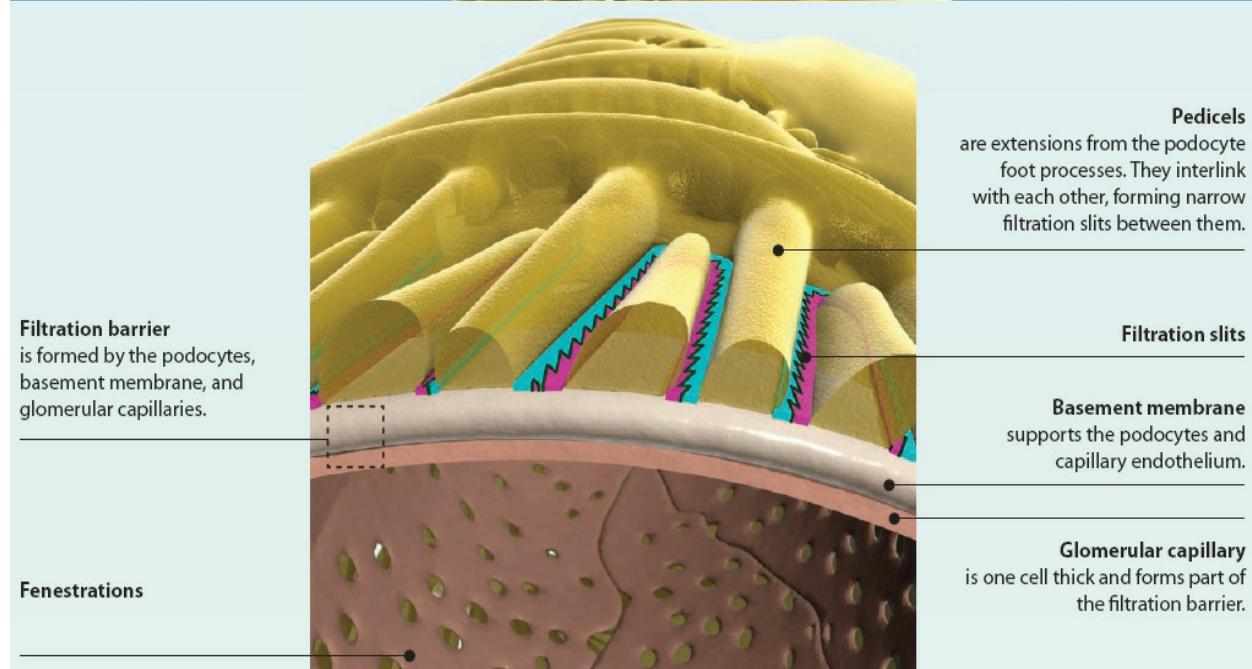
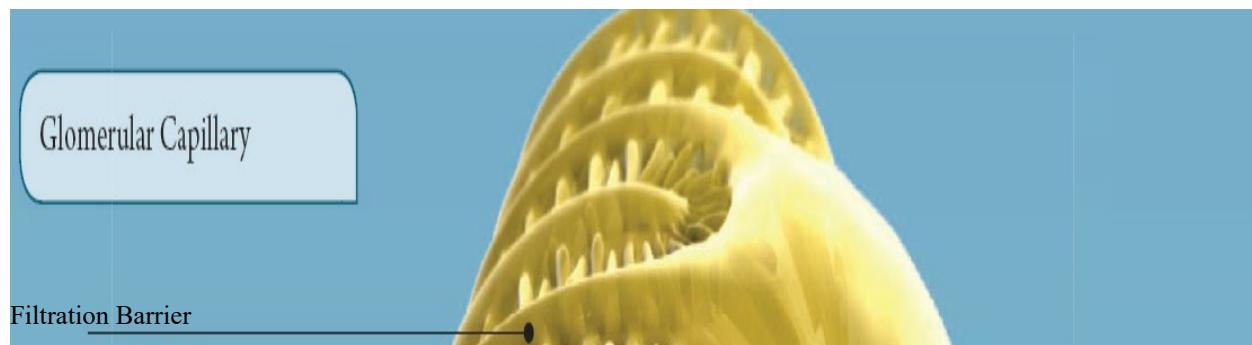


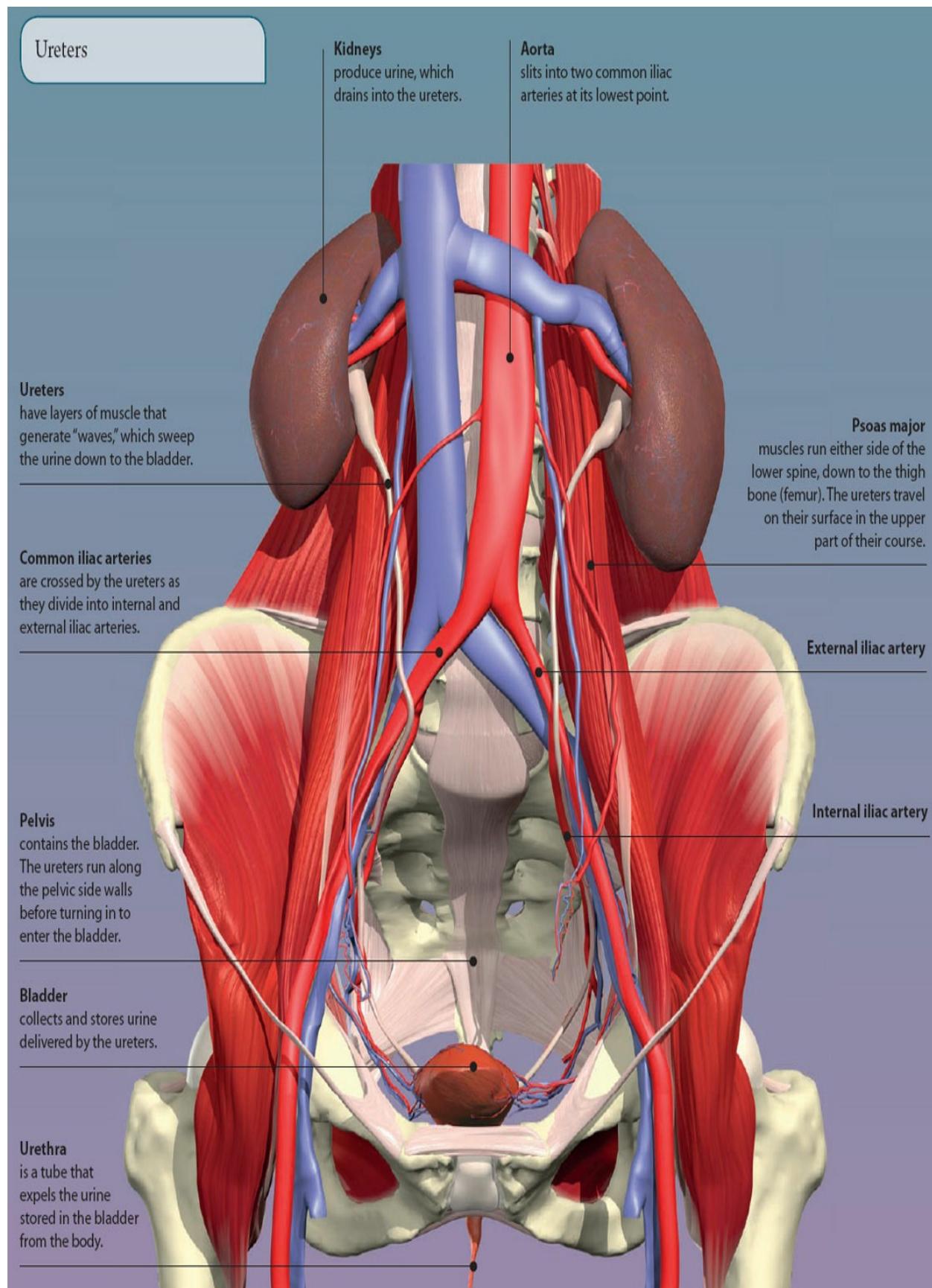
GLOMERULUS

The renal corpuscle is the specialized part of the nephron that filters the blood. It has two parts: a tight ball of capillaries called the glomerulus, and a cup-shaped Bowman's capsule, which surrounds the glomerulus.

Specialized cells called podocytes cover the glomerular capillaries. Together they form a specialized filtration barrier, which only allows certain substances to pass through from the blood, and form a filtrate within Bowman's capsule.







Renal Fascia

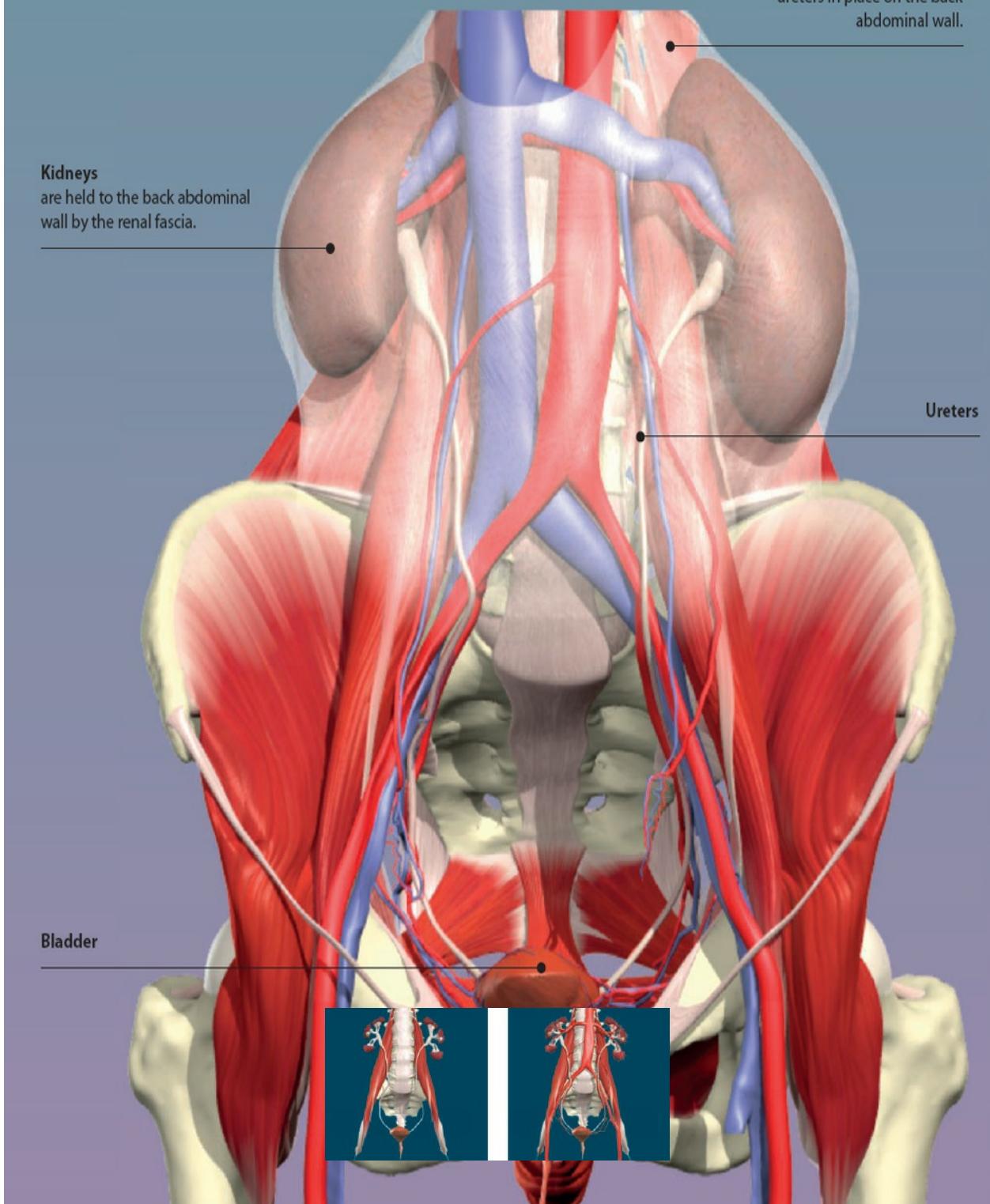
Renal fascia
is formed from fibrous tissue.
It supports the kidneys and
ureters in place on the back
abdominal wall.

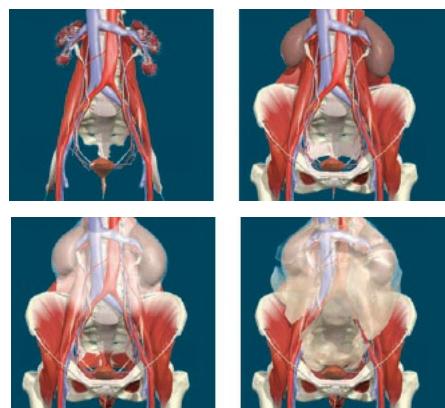
Kidneys

are held to the back abdominal
wall by the renal fascia.

Ureters

Bladder

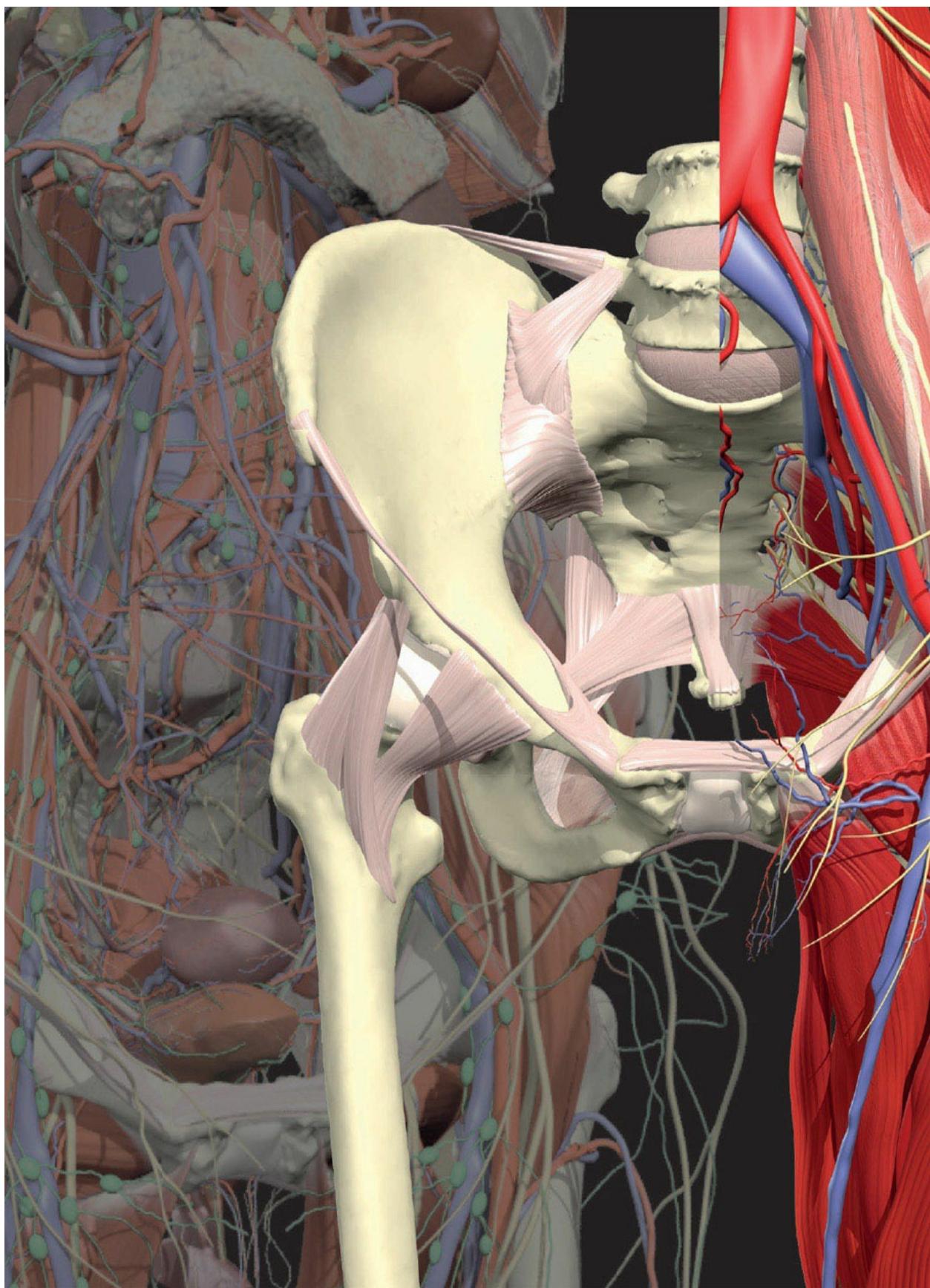




CHAPTER 6: THE PELVIS

The pelvis is the strong, bowl-shaped area at the base of the trunk, where the legs attach to the rest of the body. It is formed from the hip and lower back bones. It contains and protects the reproductive organs and lower parts of the urinary and digestive systems. A muscular sheet provides support to these organs and forms the pelvic floor.

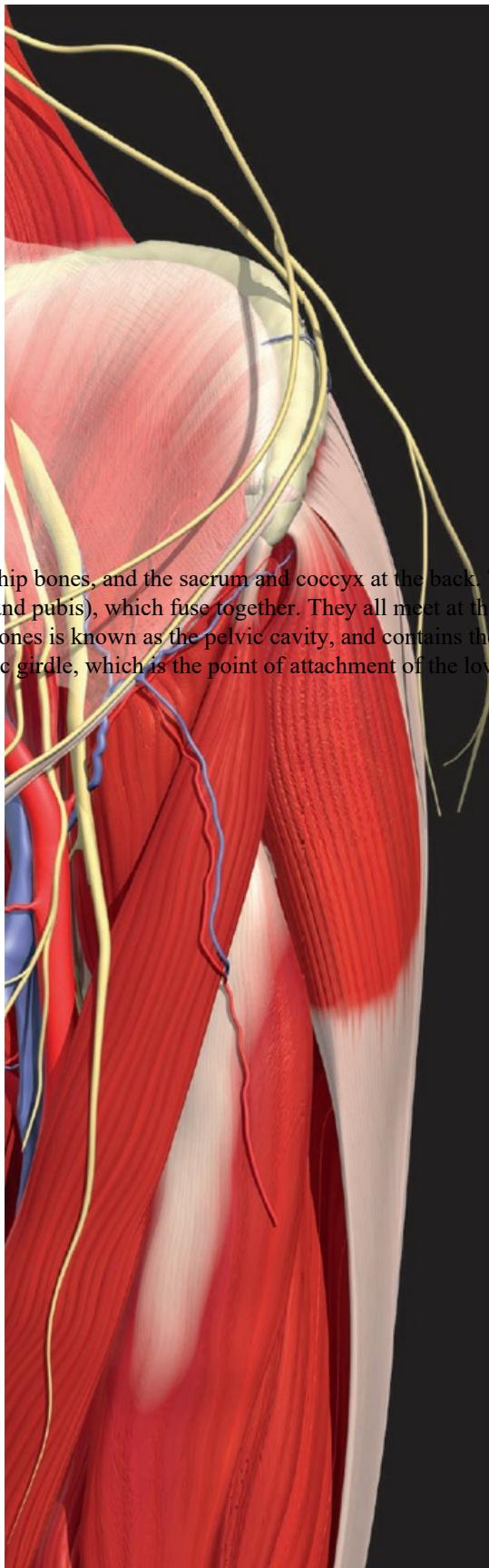
The pelvis provides attachment for various muscles that move both the trunk and the legs. The shape and position of the pelvis helps us in standing, walking, and keeping an upright position.

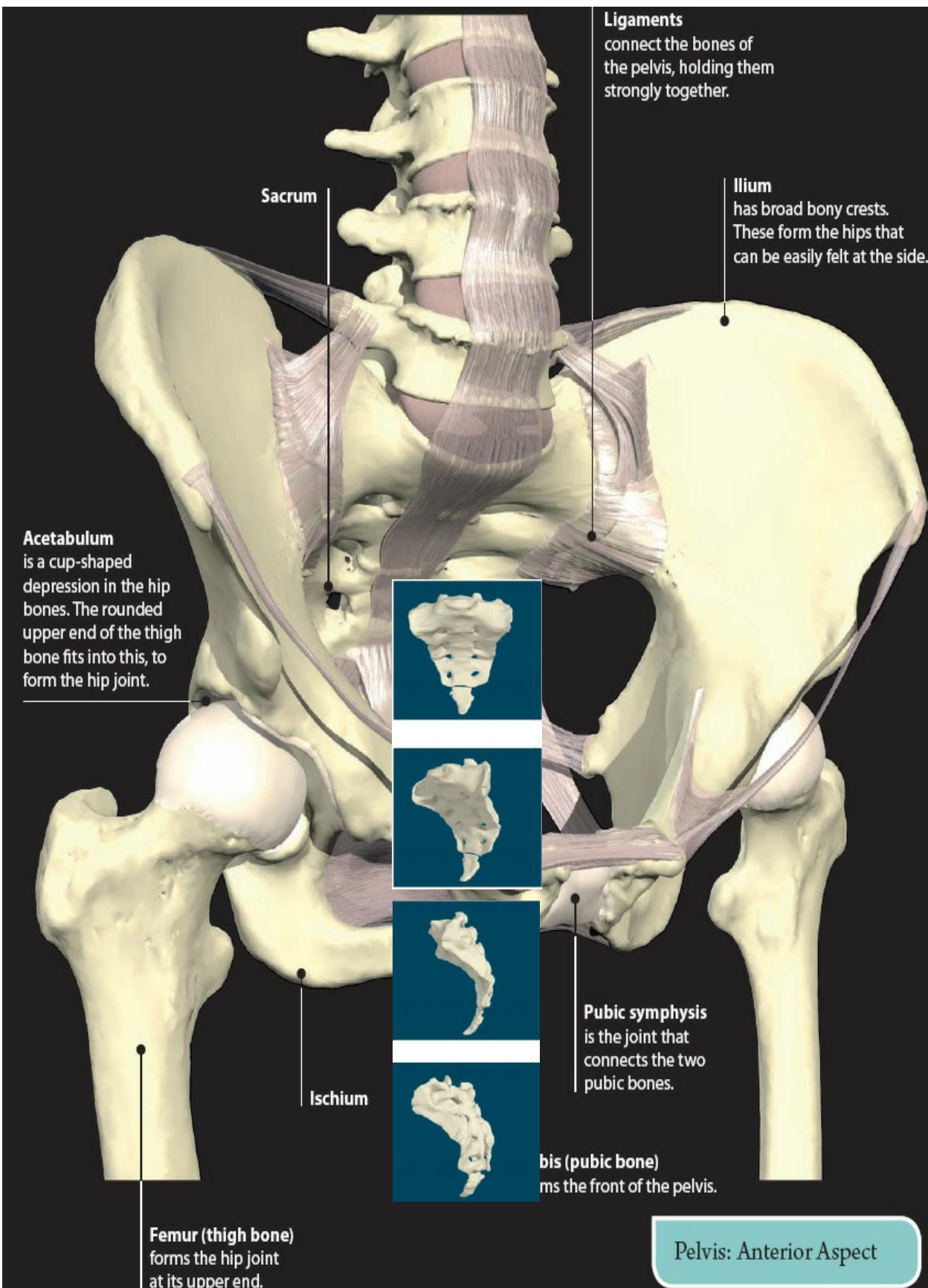


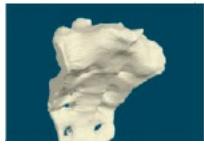
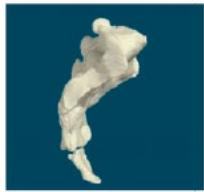
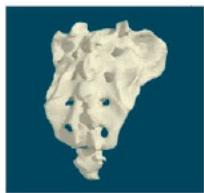
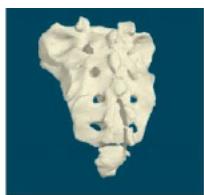
HIP BONE

The pelvis is formed by the two hip bones, and the sacrum and coccyx at the back. The hip bone is formed by three separate bones (ilium, ischium, and pubis), which fuse together. They all meet at the acetabulum. The central bowl-shaped region protected by the bones is known as the pelvic cavity, and contains the pelvic organs.

The hip bones form the pelvic girdle, which is the point of attachment of the lower limbs to the rest of the body.



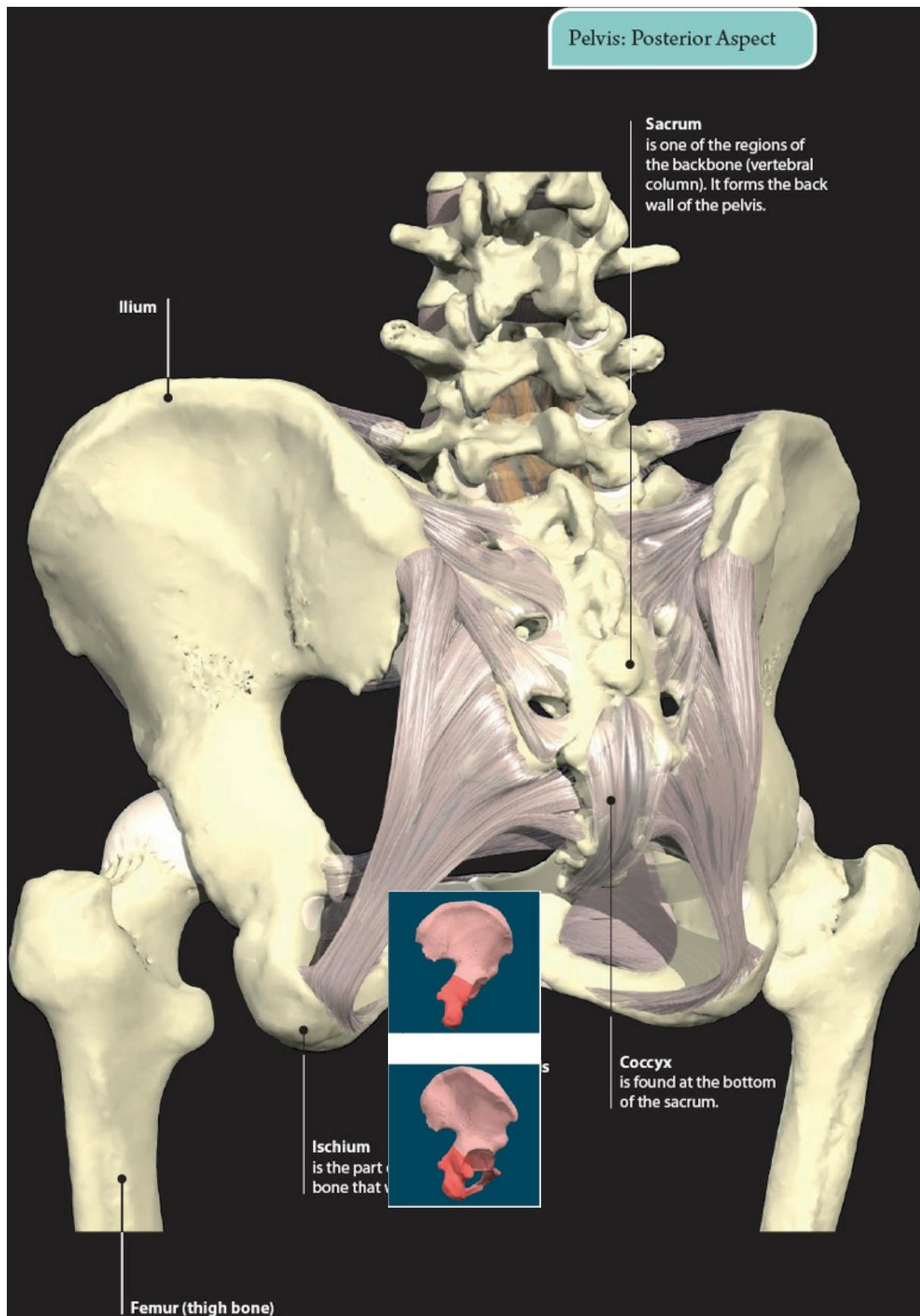




Did you know?

In diseases that affect the blood cells, it is often helpful for doctors to analyze a sample of the bone marrow. A common site for obtaining this sample is either side of the lower back, where the hip bone is near the surface. A special needle is passed into the bone, and a sample of marrow is obtained.

Pelvis: Posterior Aspect





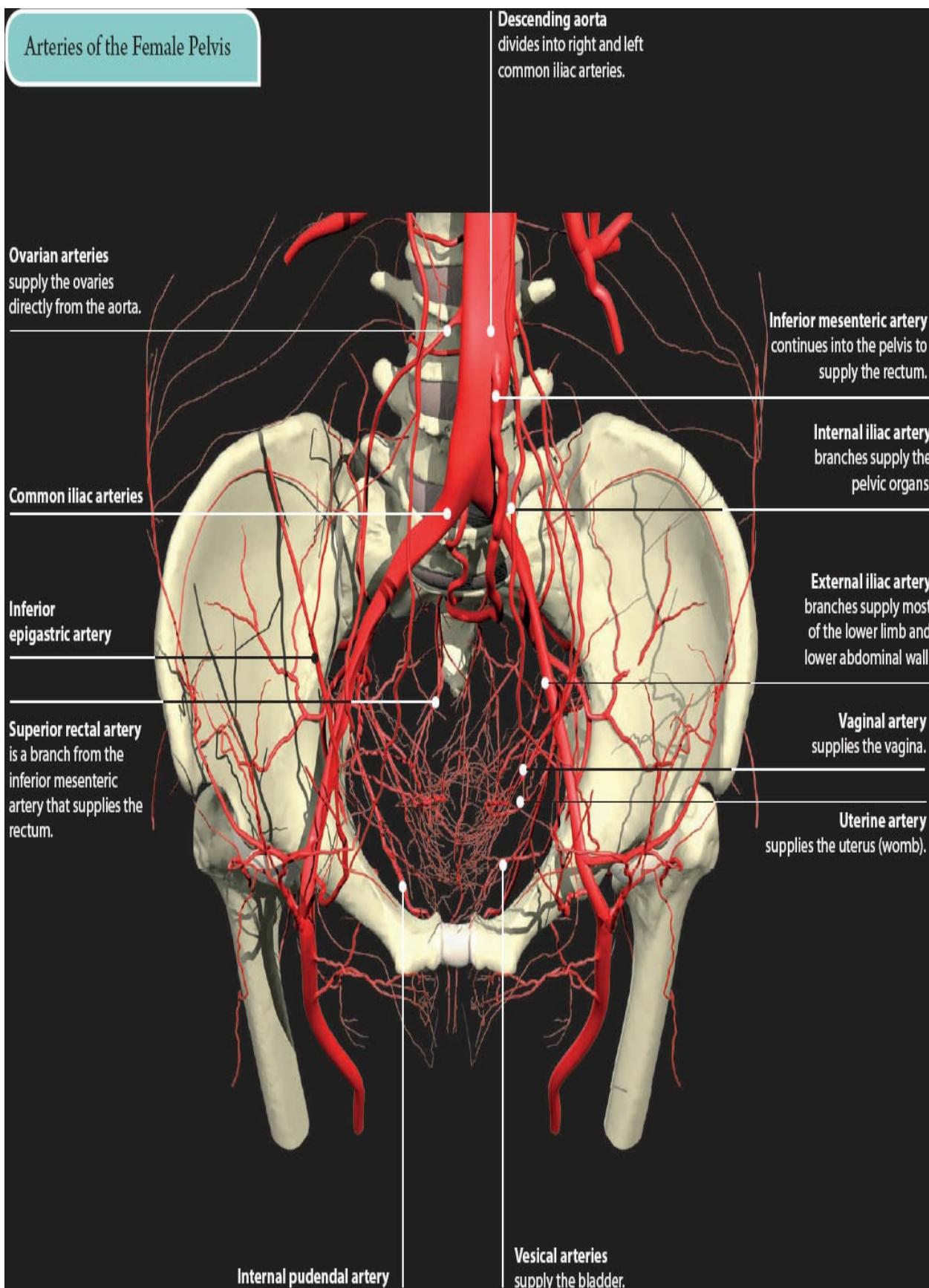
VESSELS OF THE PELVIS

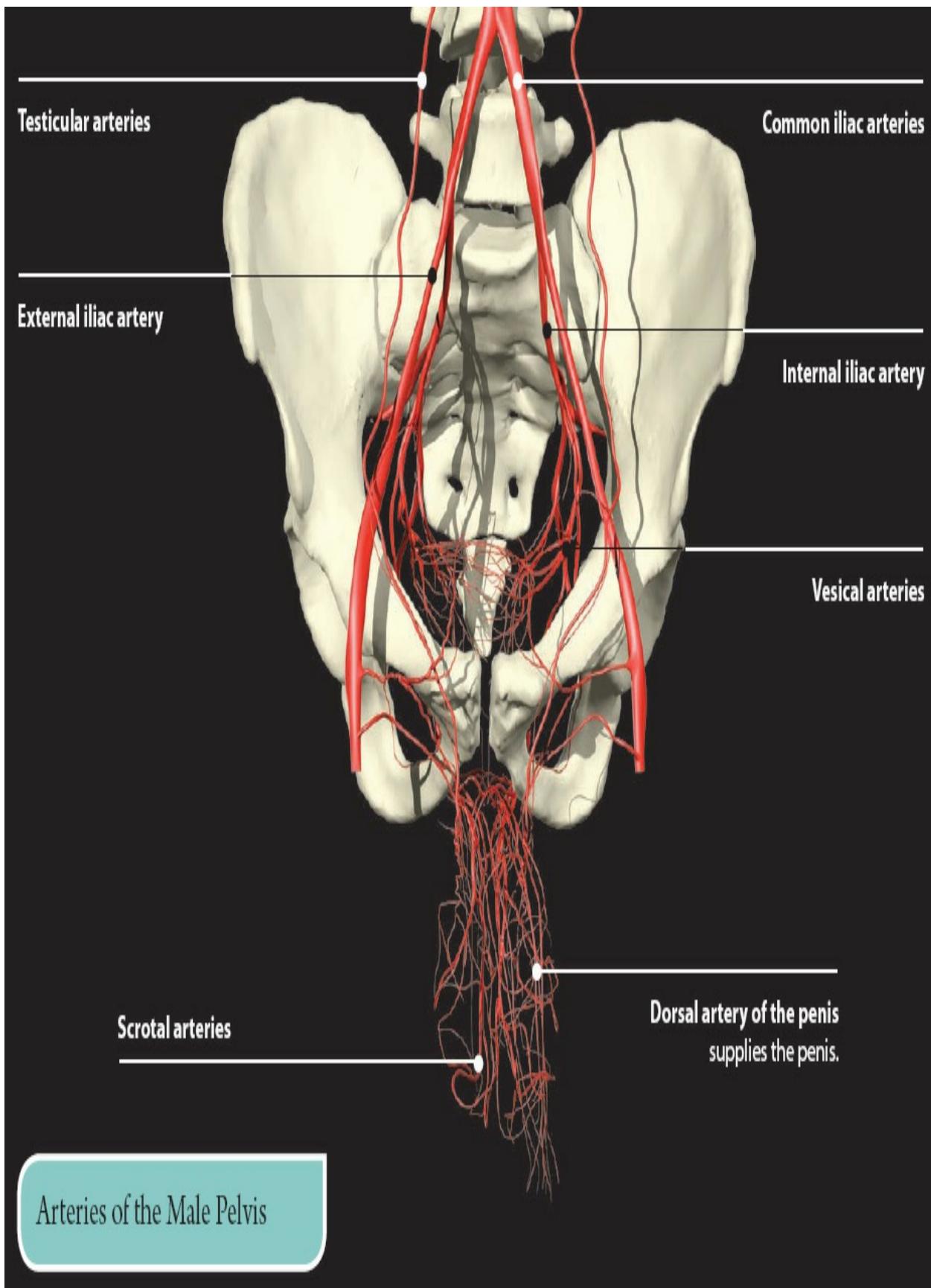
The descending aorta splits into two common iliac arteries just above the pelvis. These vessels and their branches supply the pelvic organs and the lower limbs.

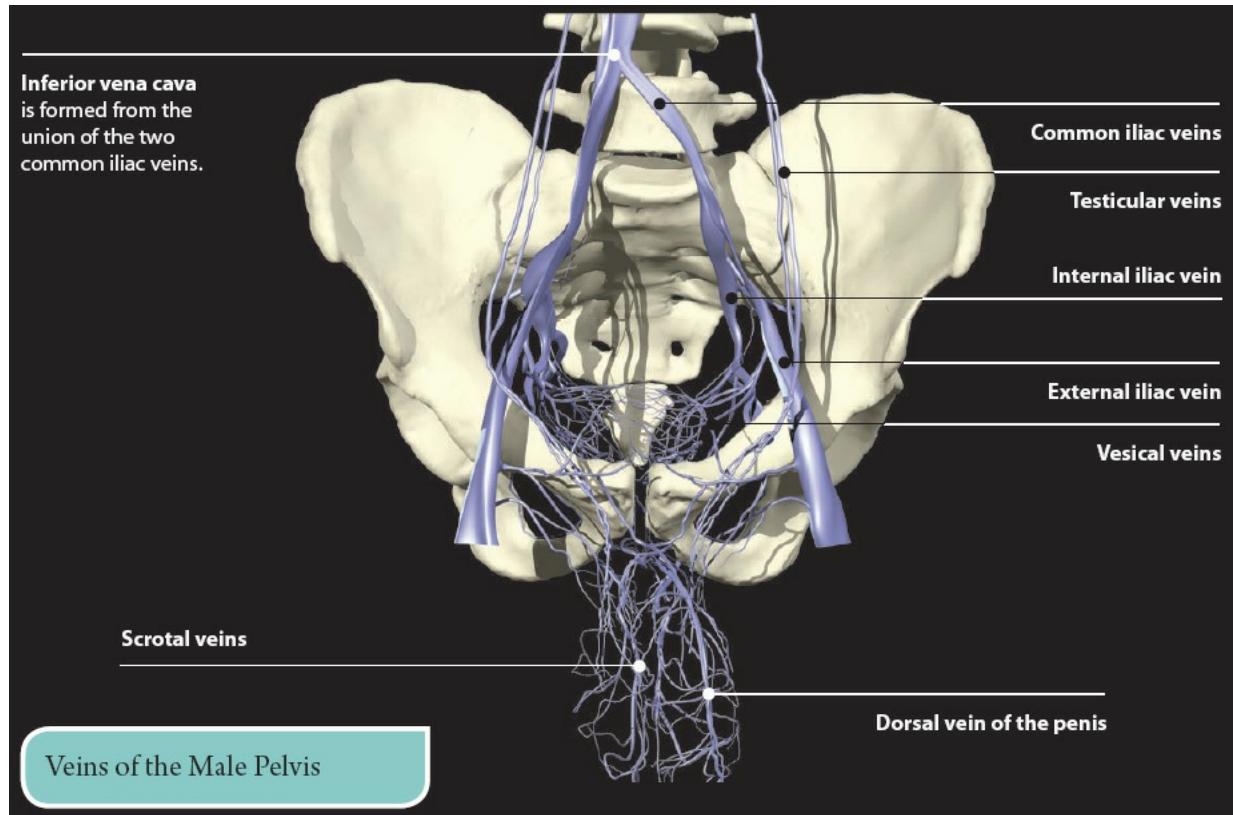
Although most blood vessels are the same in males and females, there are some variations that reflect the differences in the reproductive organs.

In general, the veins of the pelvis follow the same pattern as the arteries.

Arteries of the Female Pelvis









NERVES OF THE PELVIS

The pelvis contains the nerves that form the sacral plexus, along with branches from the lumbar plexus. Between them, these collections of nerves supply the organs, muscles, and skin of the pelvis and lower limb.

Nerves of the Female Pelvis

Lumbosacral trunk
is a contribution of nerve fibers from the lumbar plexus to the sacral plexus.

Sciatic nerve

Piriformis

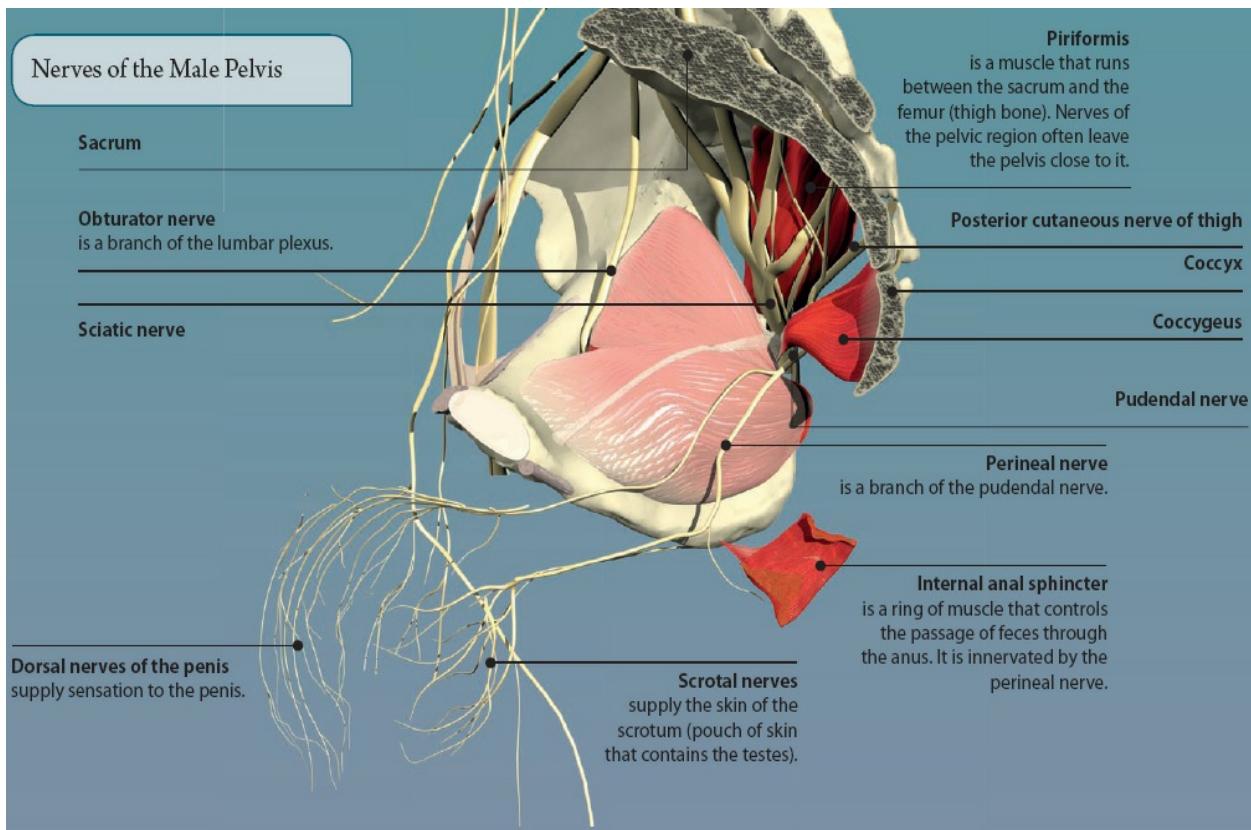
Coccygeus
is a muscle that forms part of the pelvic floor at the back.

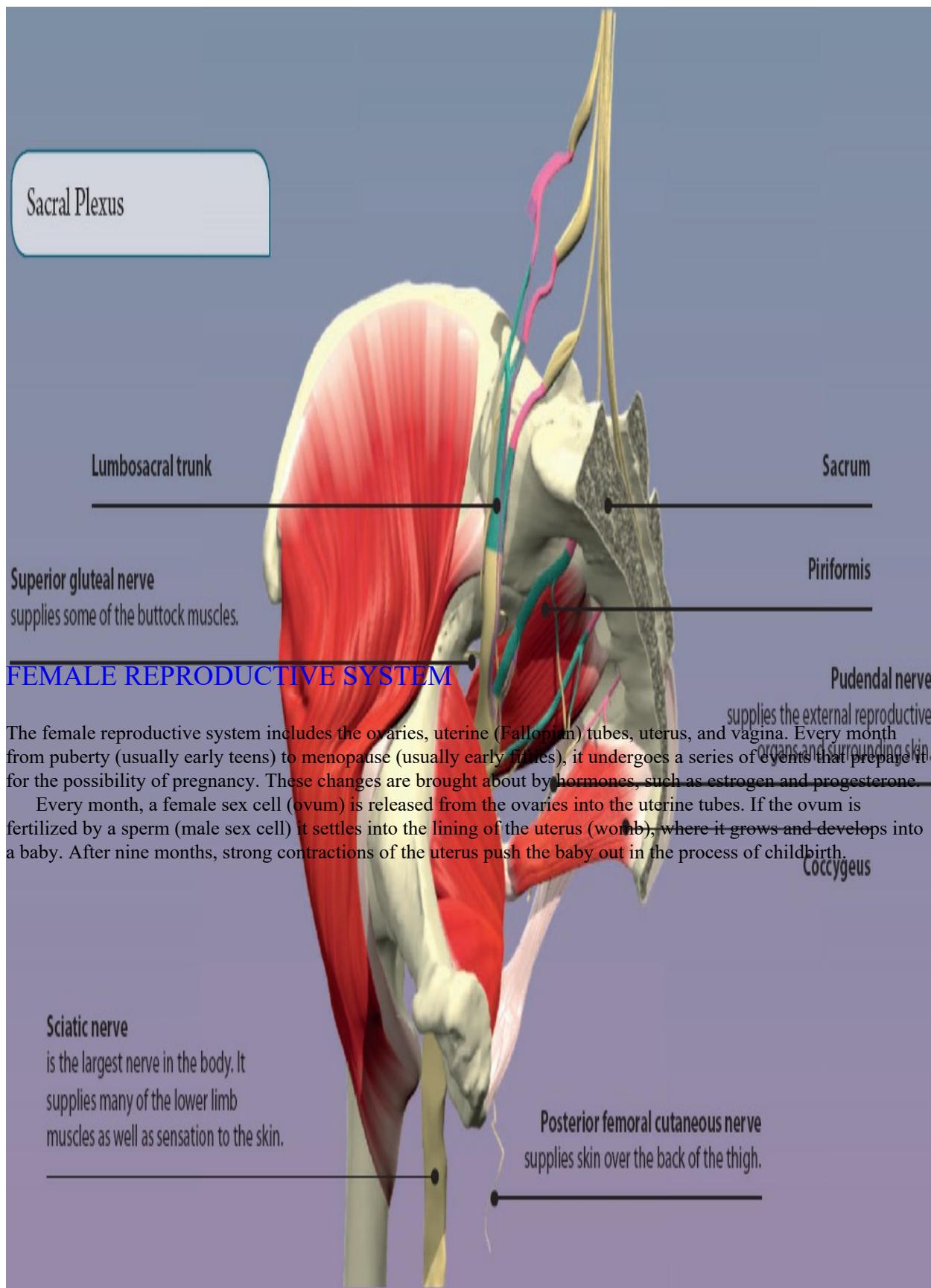
Pelvic floor

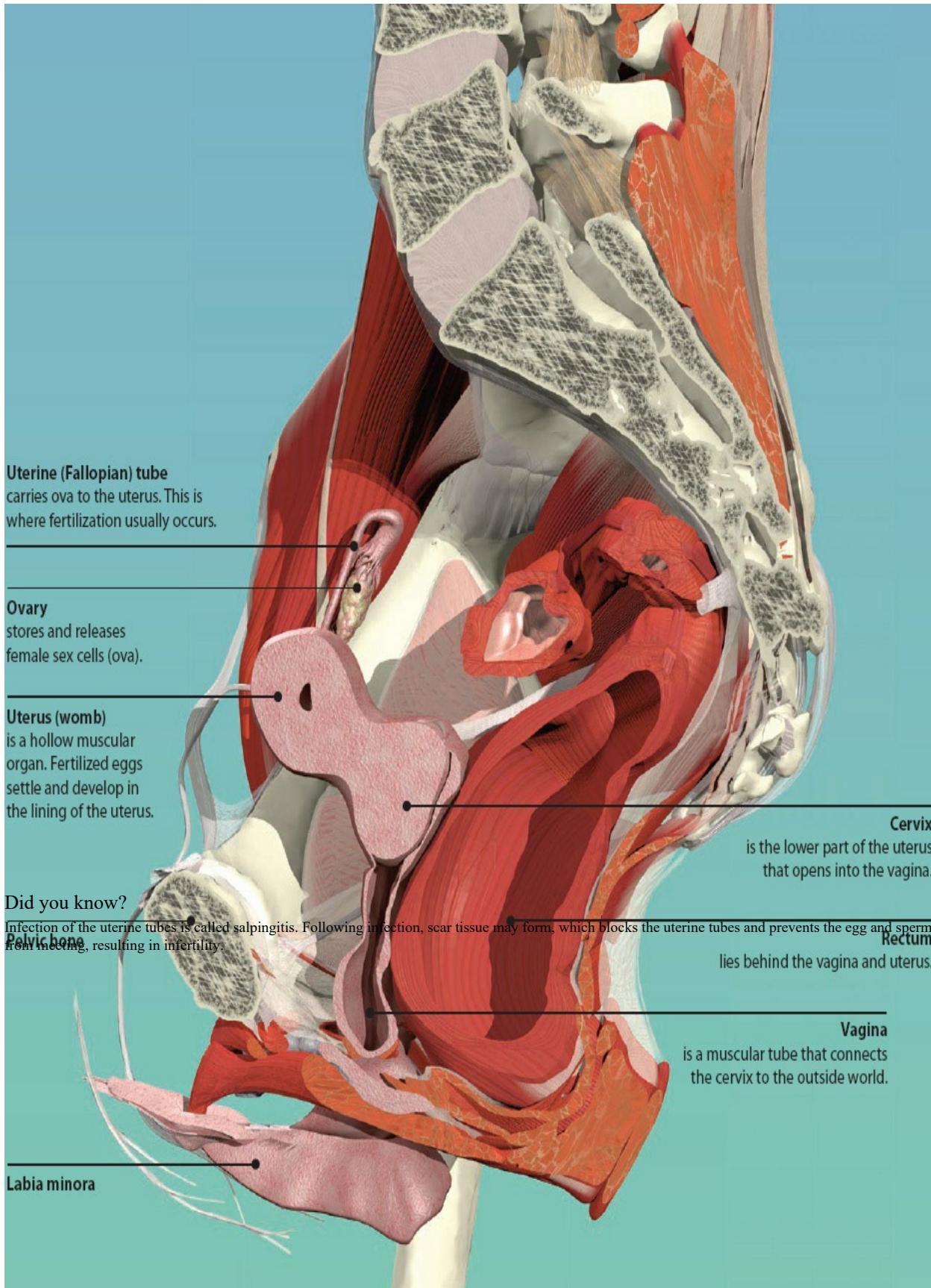
is formed from a sheet of muscles. It supports the pelvic organs and provides openings for the urethra, vagina, and anus to reach the outside.

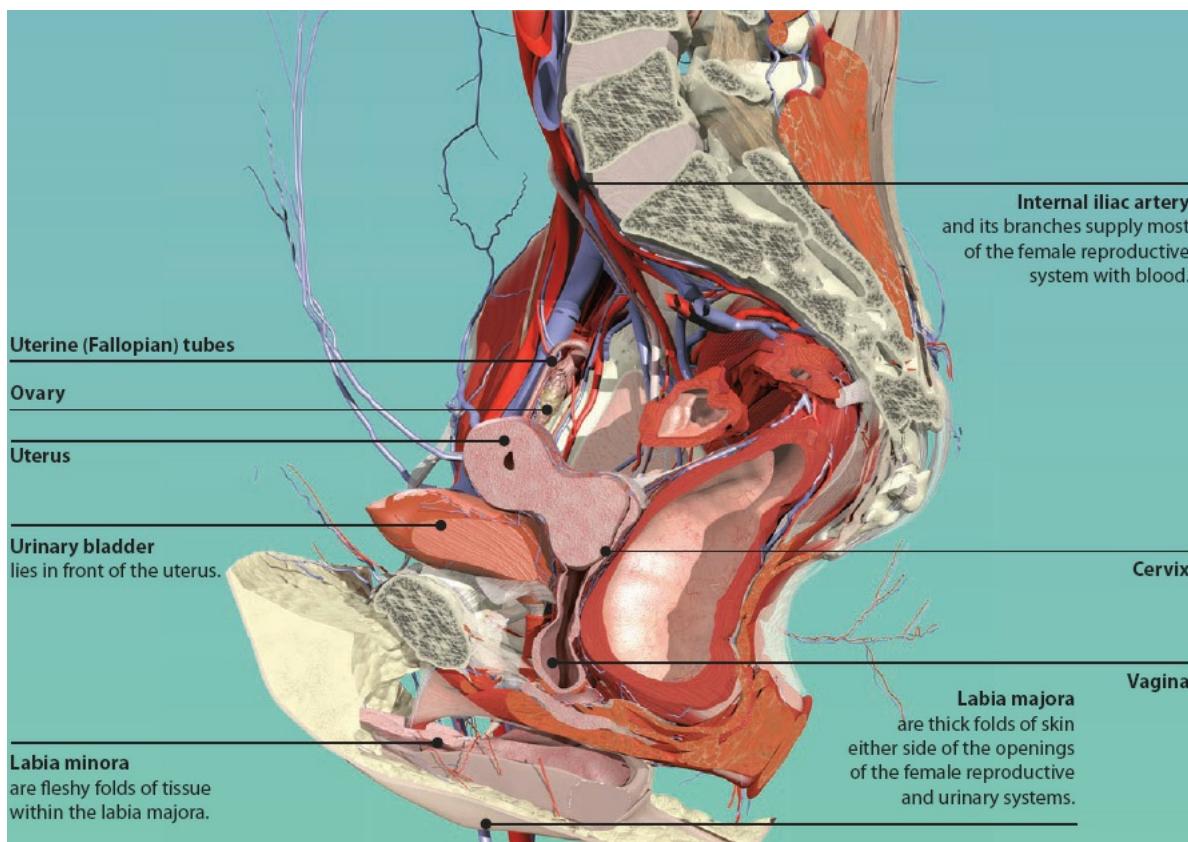
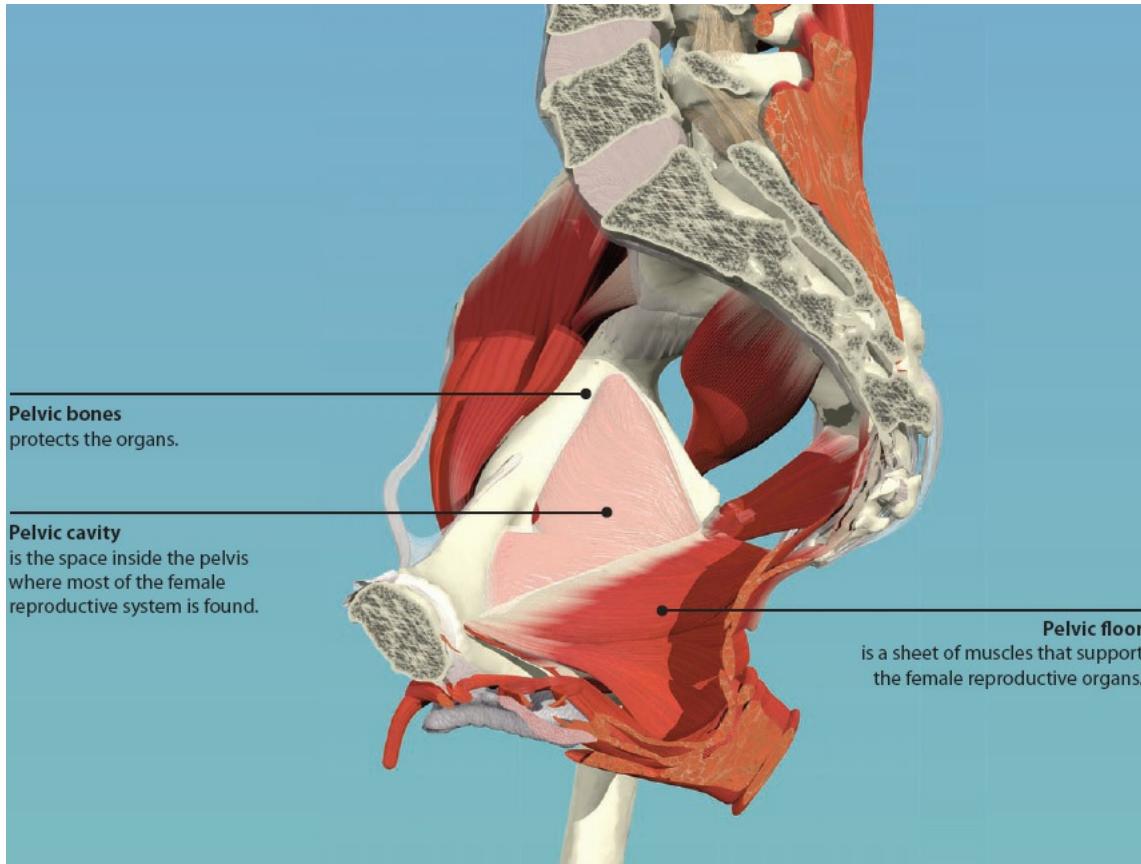
Femoral nerve
supplies the muscles at the front of the thigh.

Inferior hypogastric plexus
provides innervation to the pelvic organs.





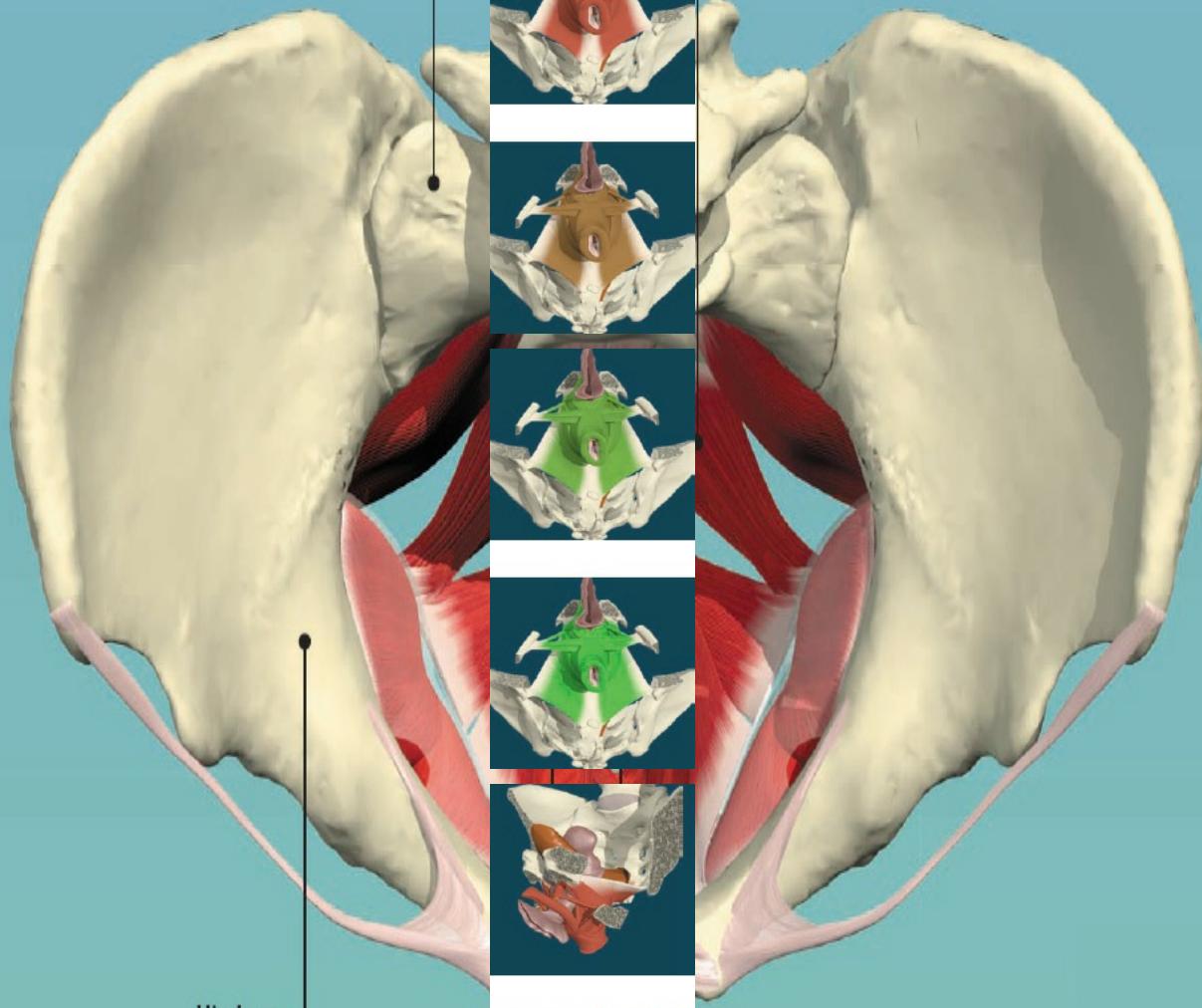




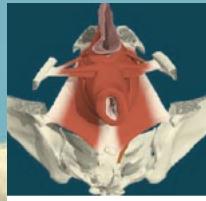
FEMALE PELVIC FLOOR

The pelvic floor is a muscular sheet that forms the base of the pelvic cavity. It is made up of numerous muscles, suspended from the pelvic bones. These form a hammocklike support for the pelvic organs. In the female it has openings for the urethra, vagina, and anus.

Female Pelvic Floor: Superior Aspect



Sacrum & coccyx
form the back wall
of the pelvis.



Coccygeus
is a muscle that forms the back of
the pelvic floor, running between
the coccyx and the hip bone.

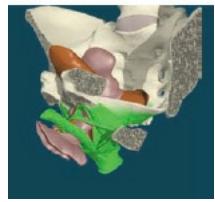
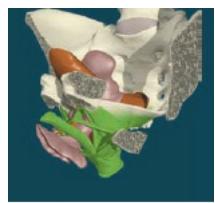


Hip bone
provides attachment for many of
the pelvic floor muscles.

Levator ani
is a large muscle which forms the
majority of the pelvic floor.

Internal anal sphincter
surrounds and compresses the upper
part of the anal canal.

Sphincter urethrae muscle
surrounds and compresses the
urethra, allowing us to control
when to urinate.

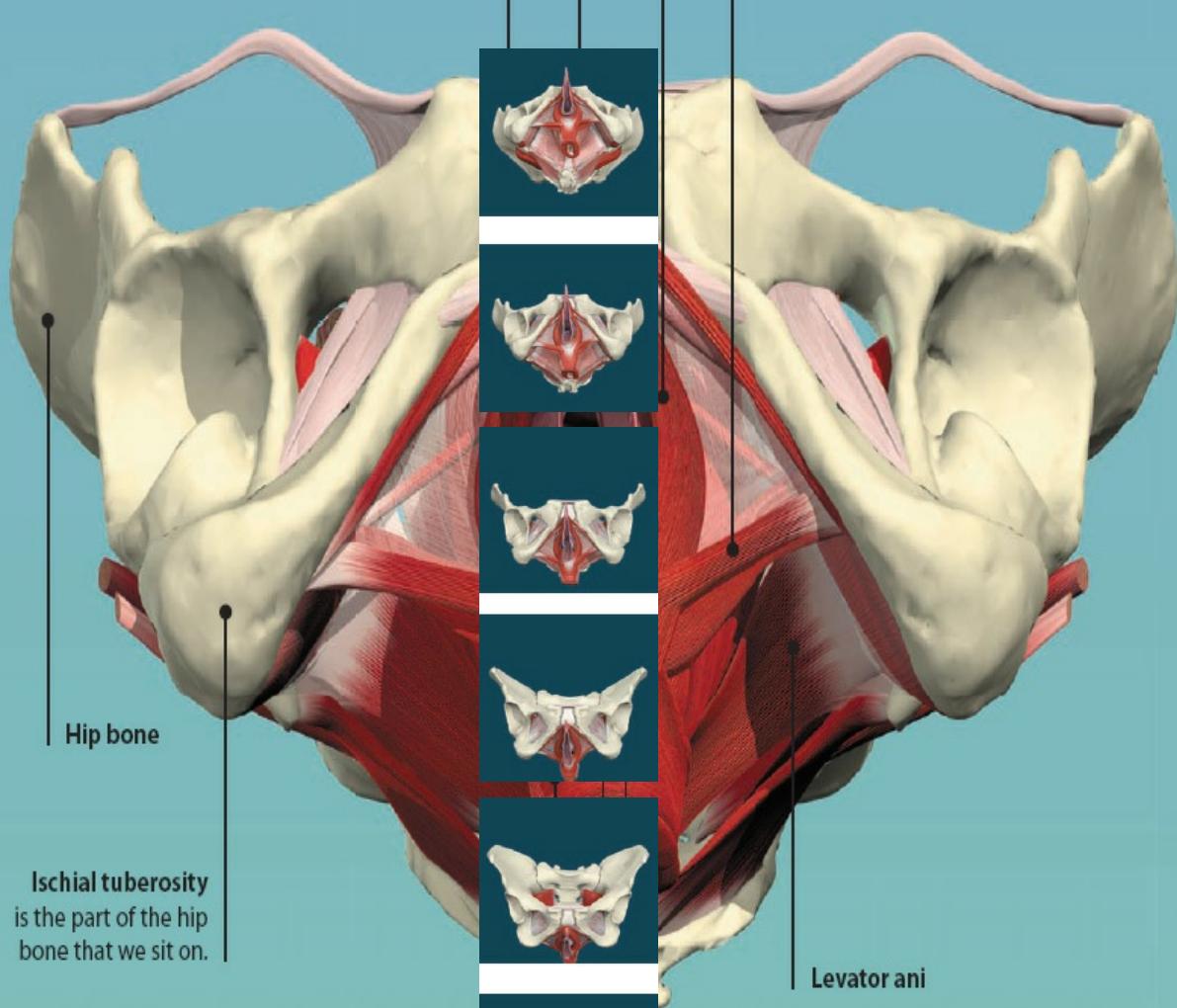


Female Pelvic Floor: Inferior Aspect

Clitoris
is involved in the sexual response.

Bulbospongiosus muscle
passes either side of the vagina,
narrowing its opening.

**Superficial and deep transverse
perineal muscles**
attach the perineal body
to the hip bones.



Hip bone
Ischial tuberosity
is the part of the hip
bone that we sit on.

External anal sphincter
surrounds and compresses the
anal canal, giving us voluntary control
over the process of defecation.

Anal canal

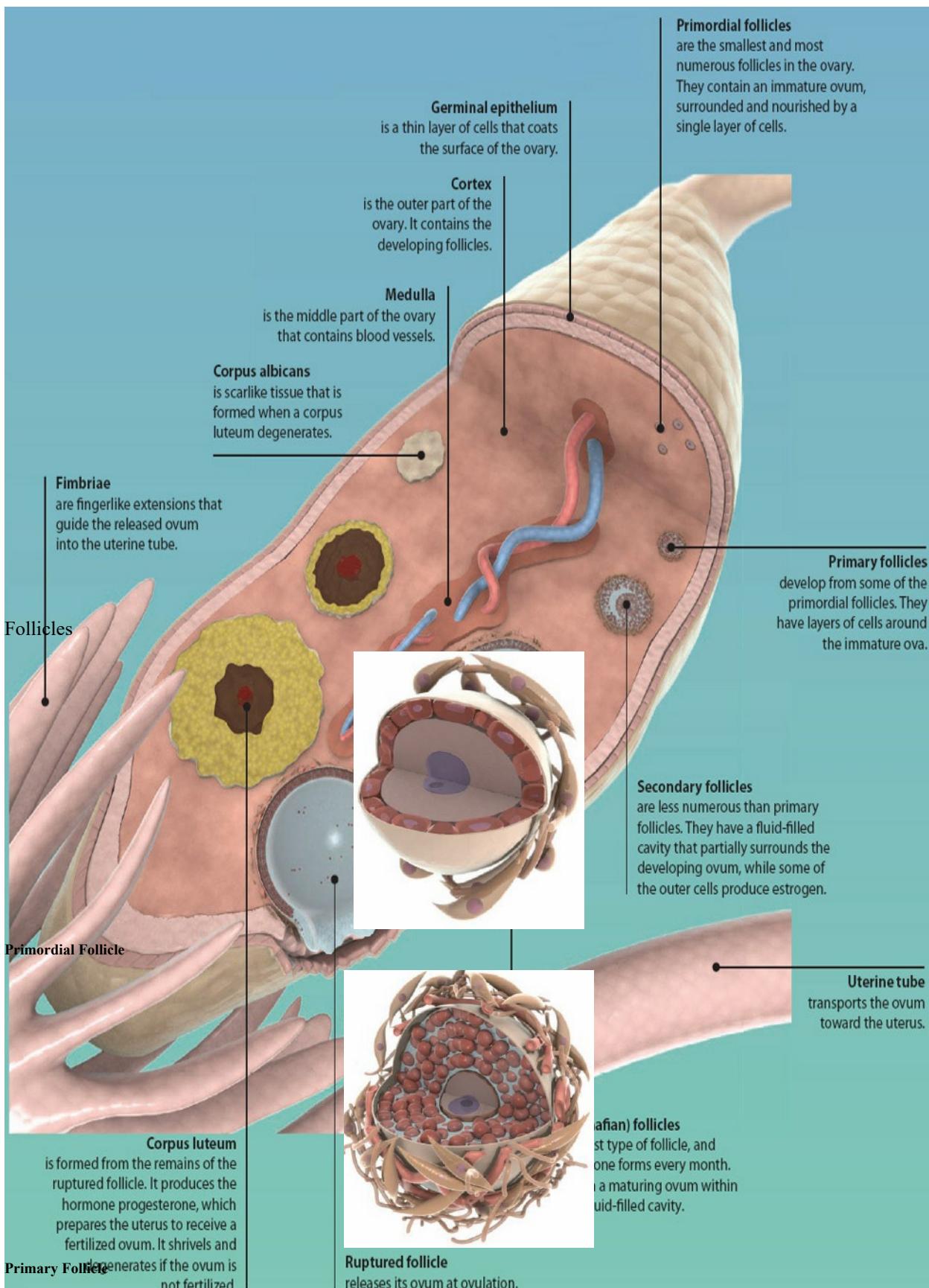
Perineal body
a tough fibrous structure lying
between the vagina and the anus. It
provides a central point of attachment
for the pelvic floor muscles.

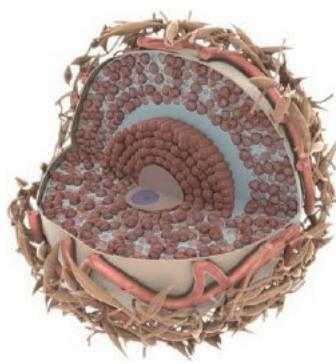
Vagina



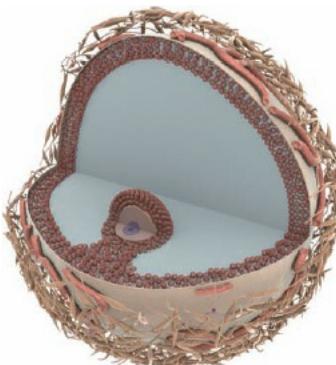
OVARIES

The ovaries are paired almond-shaped structures located within the peritoneal cavity, close to the entrance to the uterine tubes. At birth, the ovaries contain all the developing female gametes, called ova (eggs). These are surrounded by specialized cells to form follicles. Every month during the reproductive years, a few follicles mature and grow until one is large enough to rupture, releasing its ovum in a process called ovulation.

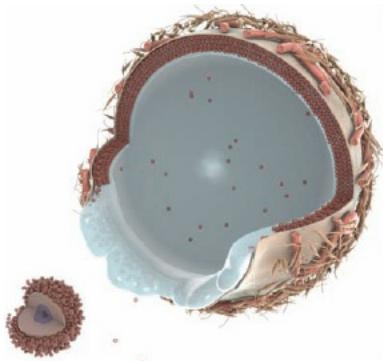




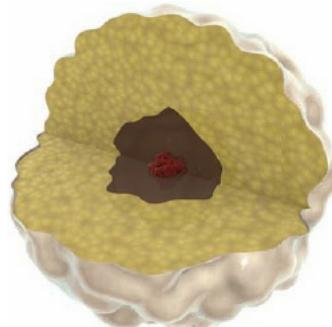
Secondary Follicle



Graffian Follicle



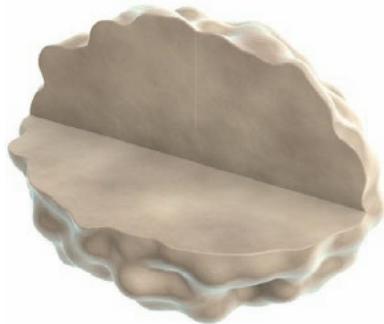
Corpus Hemorrhagicum



Corpus Luteum



Degenerating Corpus Luteum



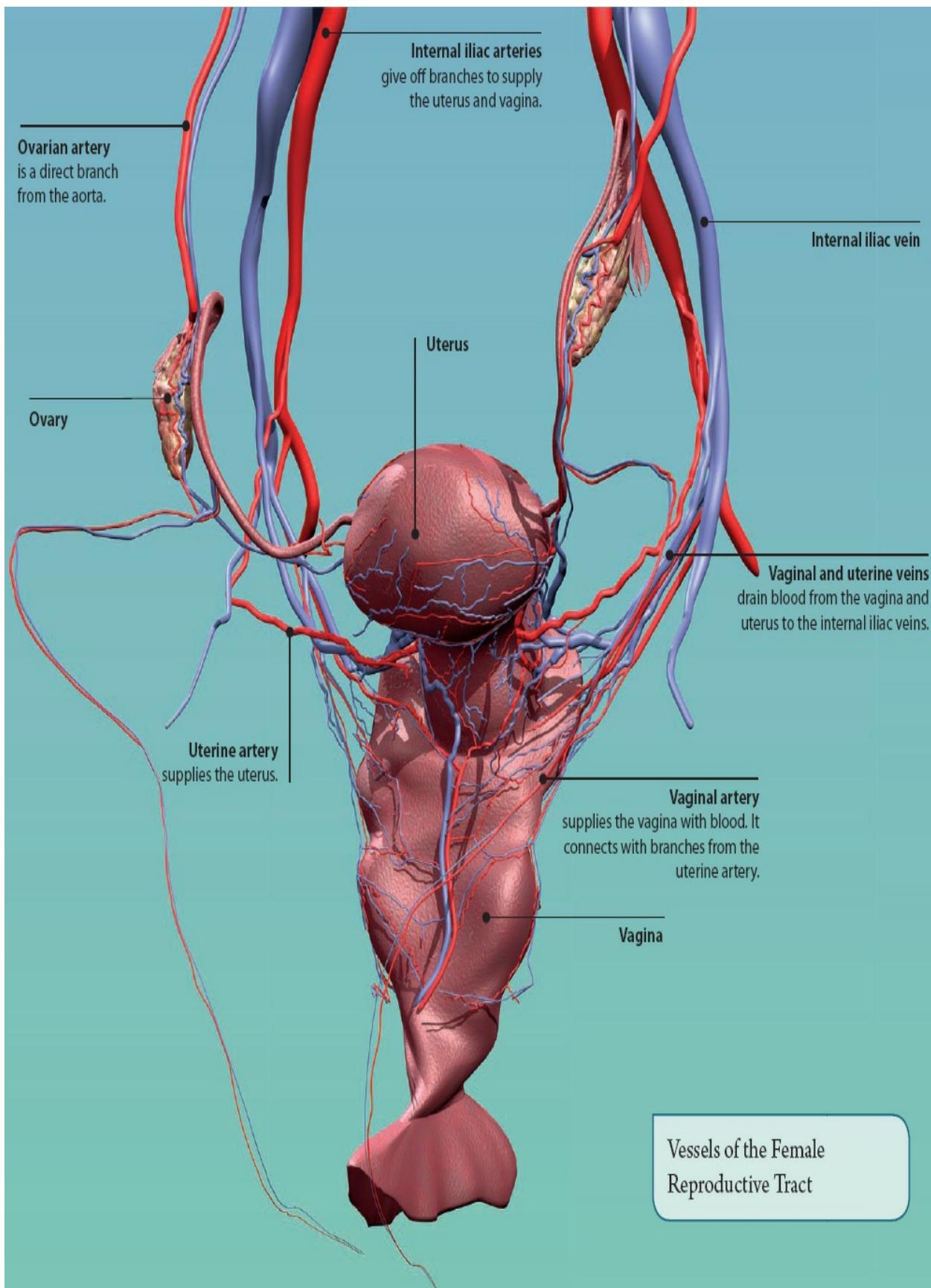
Corpus Albicans

Did you know?

Ovaries contain germ cells, which have the potential to develop into any cell in the body. These cells usually develop into egg cells (ova). However, sometimes these cells form different body tissues inside the ovary. This collection of tissue may contain hair, skin, oily secretions, and even teeth, and is called a teratoma.

FEMALE REPRODUCTIVE TRACT

The organs of the female reproductive tract are located in the pelvis. They include the ovaries, uterine (Fallopian) tubes, uterus (womb), and vagina. They produce, store, release, and transport female gametes (ova), providing a place for fertilization to take place, and offering a suitable environment for a fertilized ovum (zygote) to develop and grow.



Female Reproductive Tract: Anterior Aspect

Ovary

are paired organs that produce and store ova (eggs), releasing one each month.

Ligament of the ovary
attaches the ovary to the uterus.

Labia minora

are fleshy pieces of tissue that surround the openings of the urethra and vagina.

Uterine (Fallopian) tubes
transport ova from the ovaries to the uterus. If sperm are present, this is where fertilization takes place.

Uterus (womb)

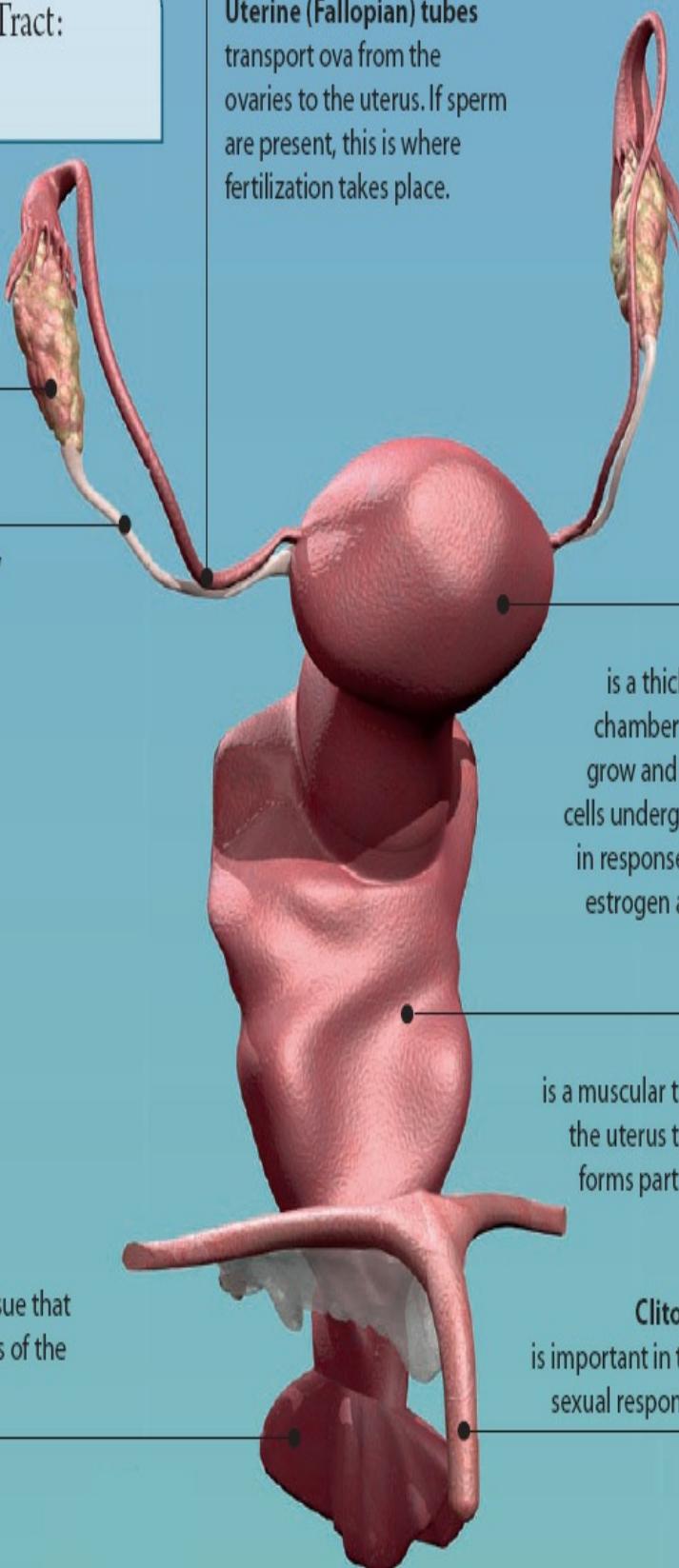
is a thick-walled muscular chamber where babies can grow and develop. Its lining cells undergo regular changes in response to the hormones estrogen and progesterone.

Vagina

is a muscular tube that connects the uterus to the outside, and forms part of the birth canal.

Clitoris

is important in the sexual response.



Infundibulum

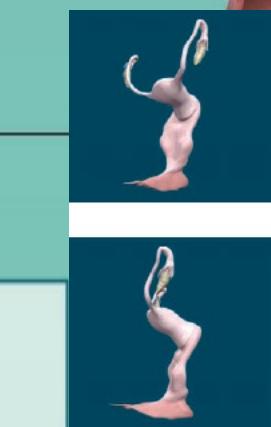
is the broad end of the uterine tube next to the ovary. Fingerlike projections, called fimbriae, guide the released ova into the uterine tube.

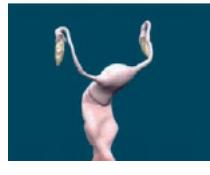
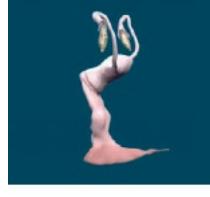
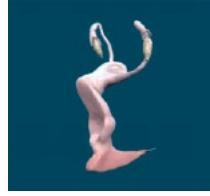
Uterine (Fallopian) tubes**Ovary****Uterus****Cervix**

is the lower part of the uterus. It forms part of the birth canal.

Vagina

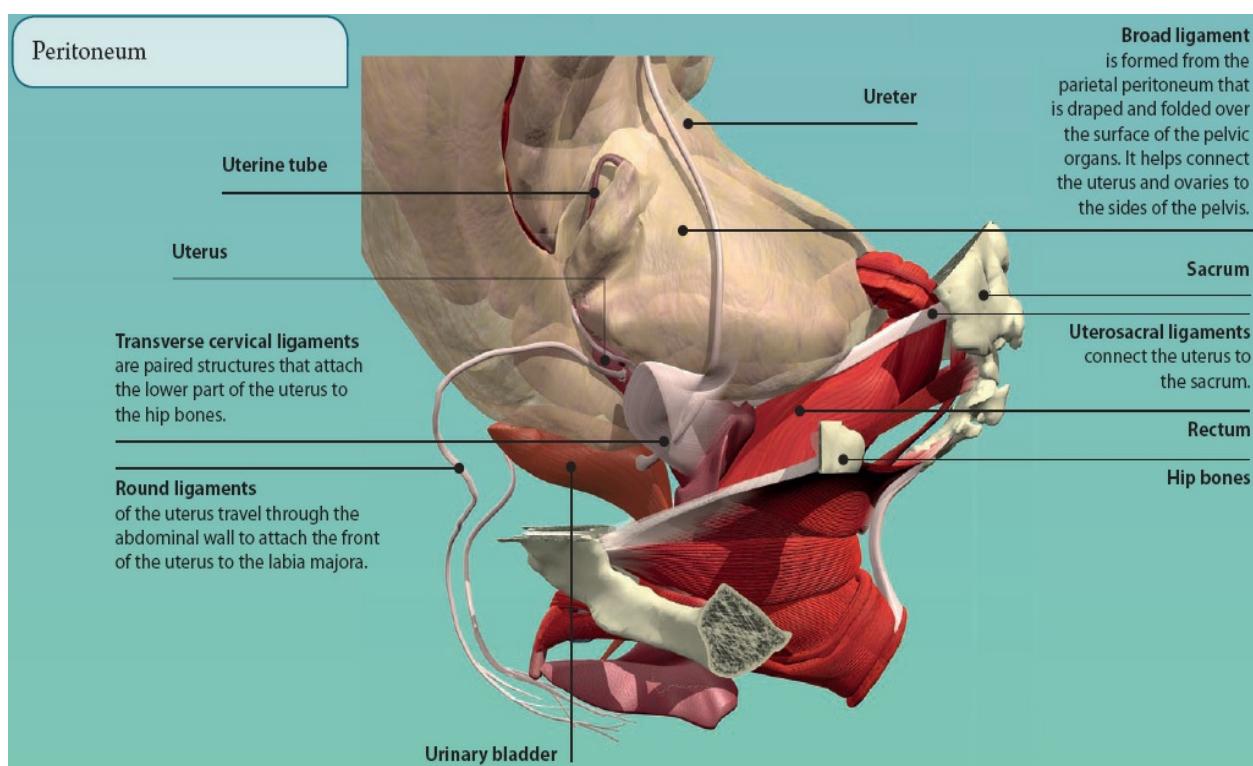
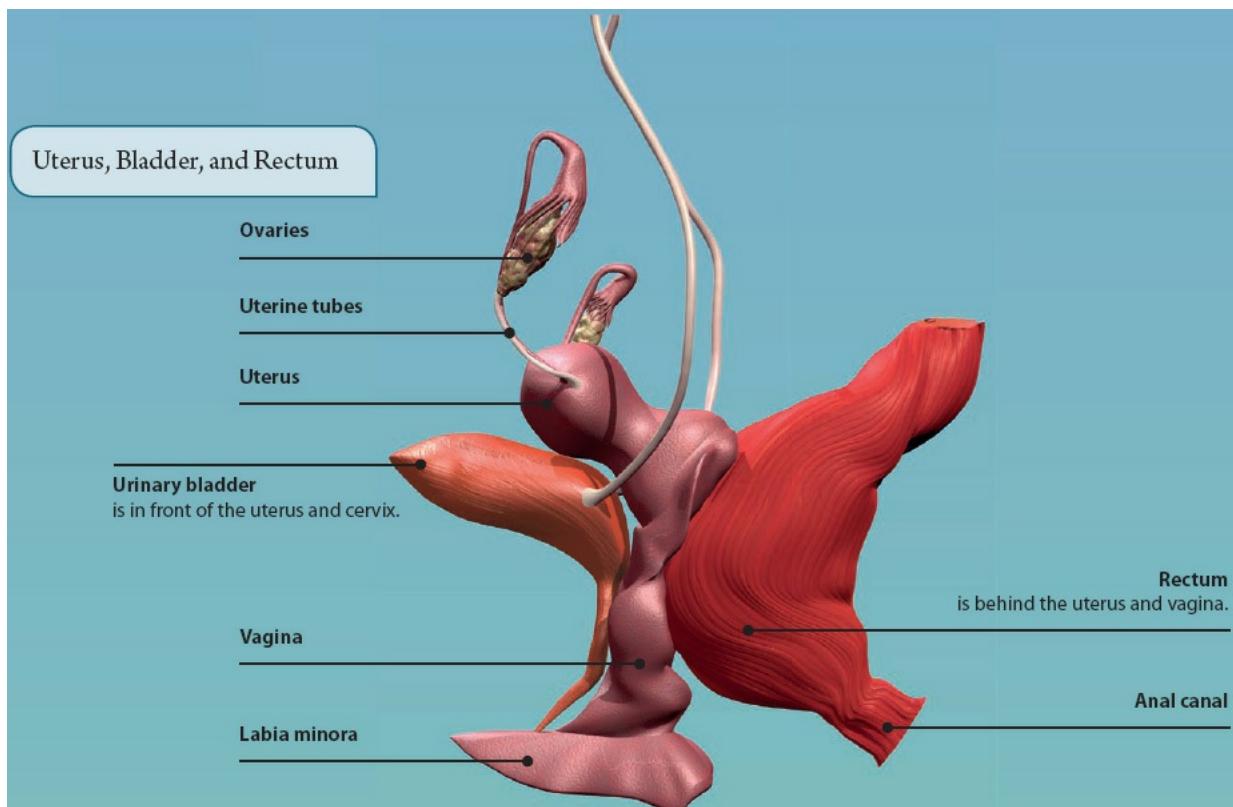
Female Reproductive Tract:
Posterior Aspect

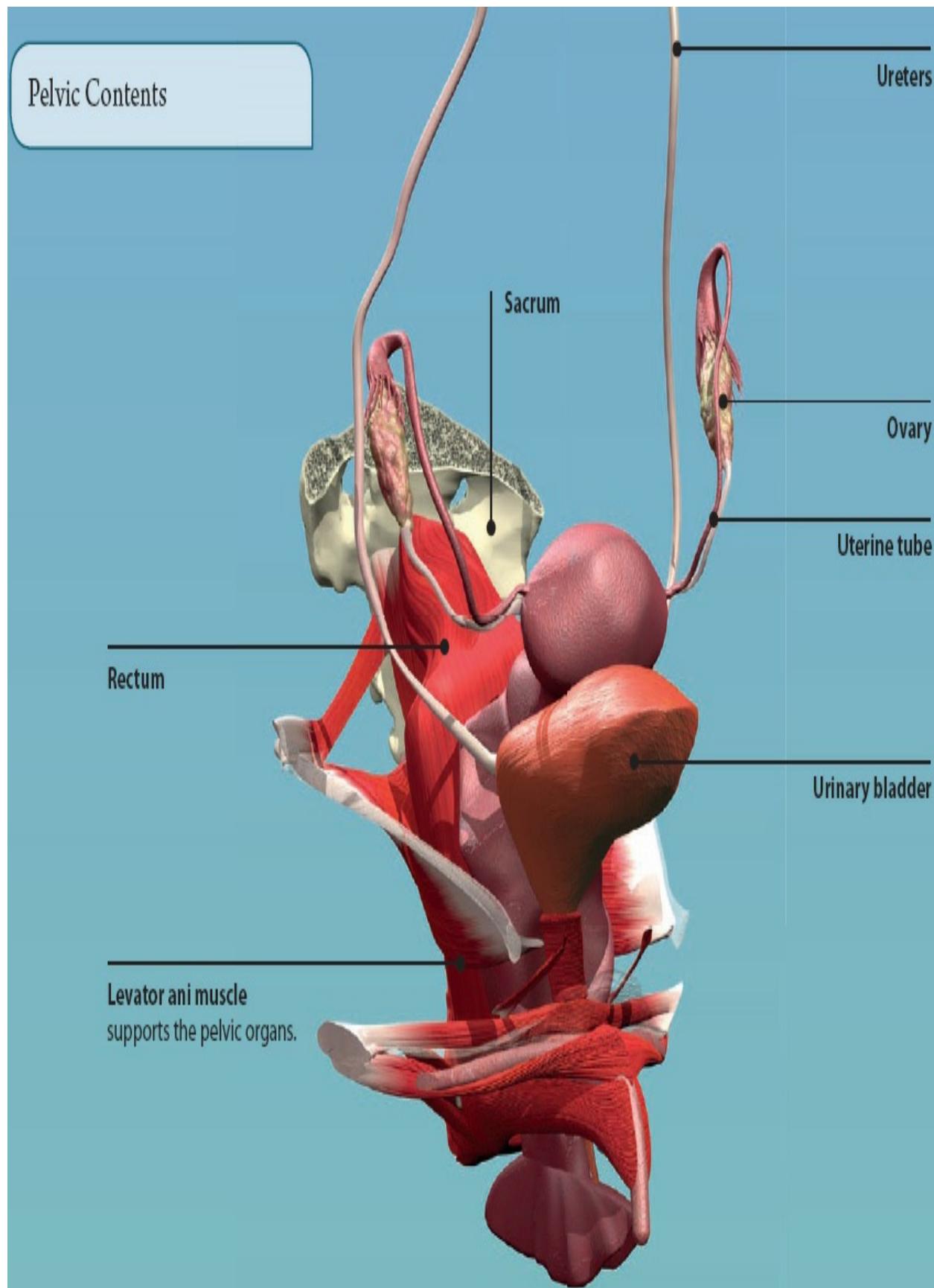
Labia minora

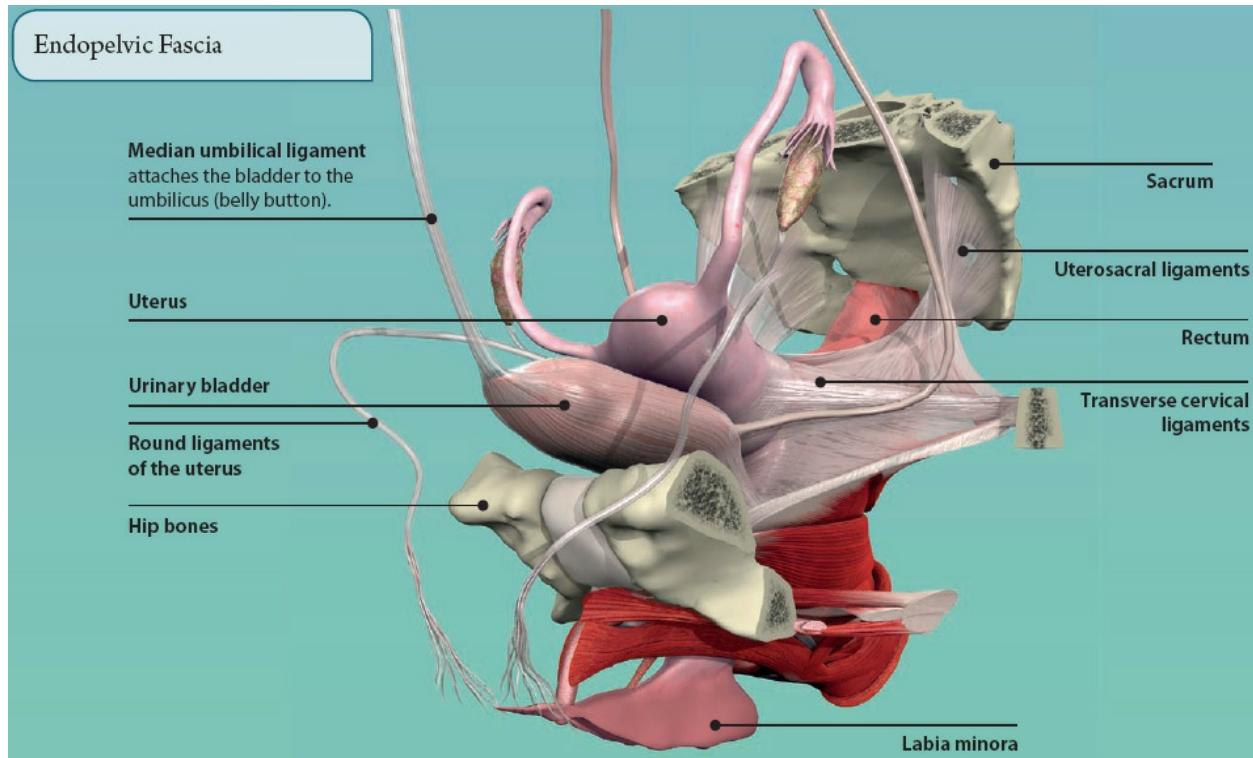


POSITION AND SUPPORT OF THE UTERUS

The uterus is located in the pelvis, positioned between the urinary bladder and the rectum. The uterus is held in place by a number of ligaments, which attach it to the pelvic bones and surrounding tissues.



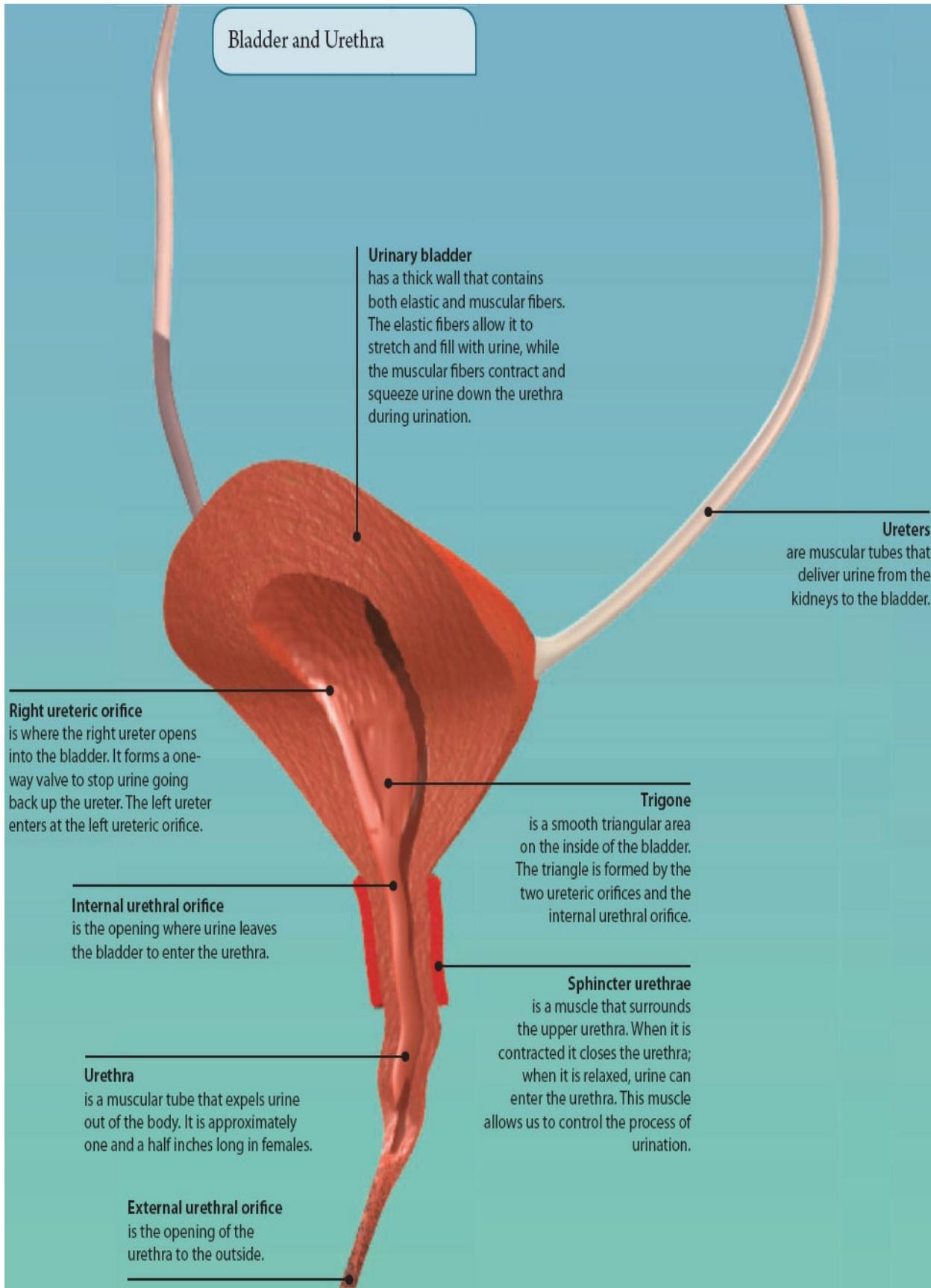


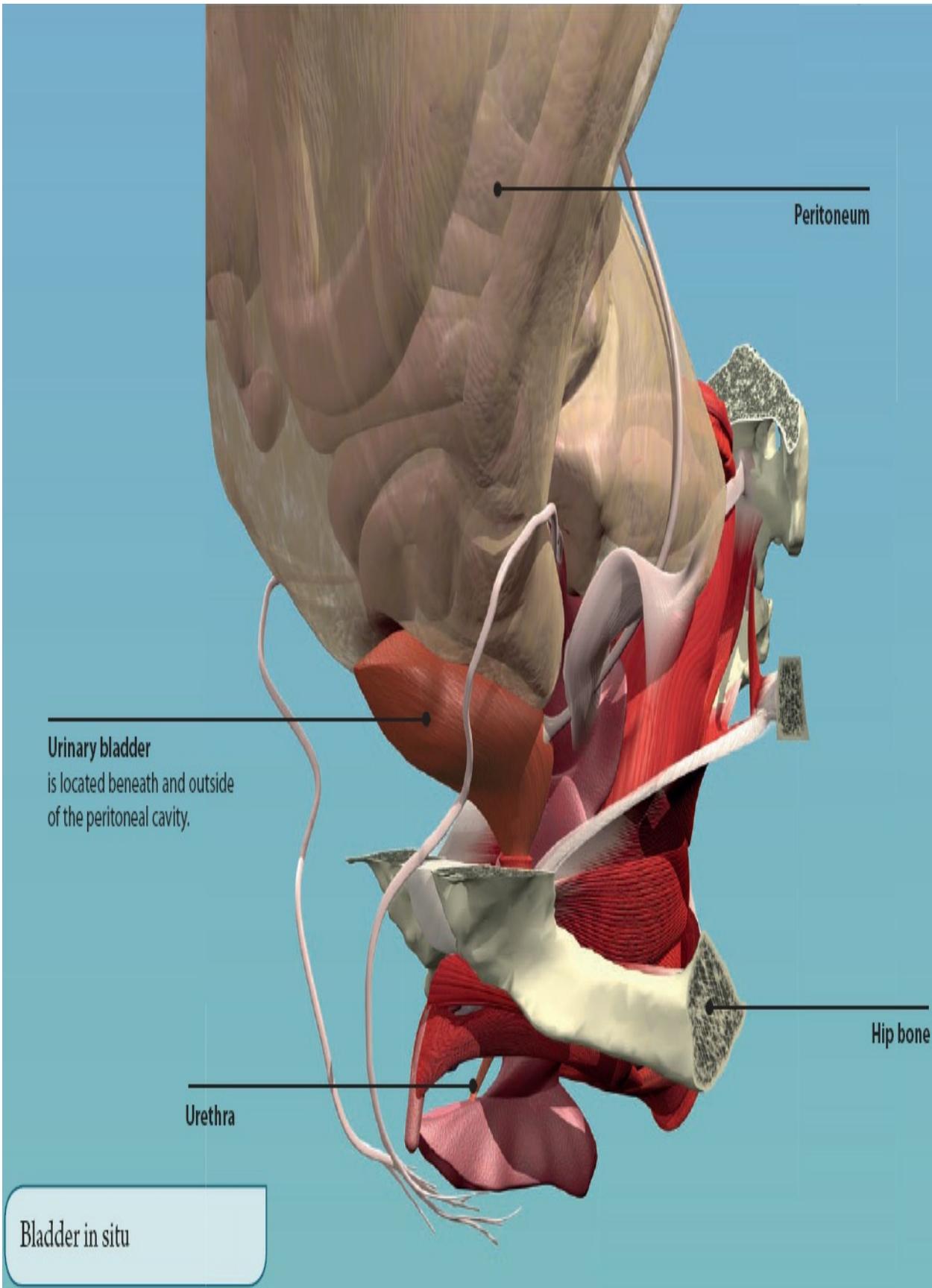


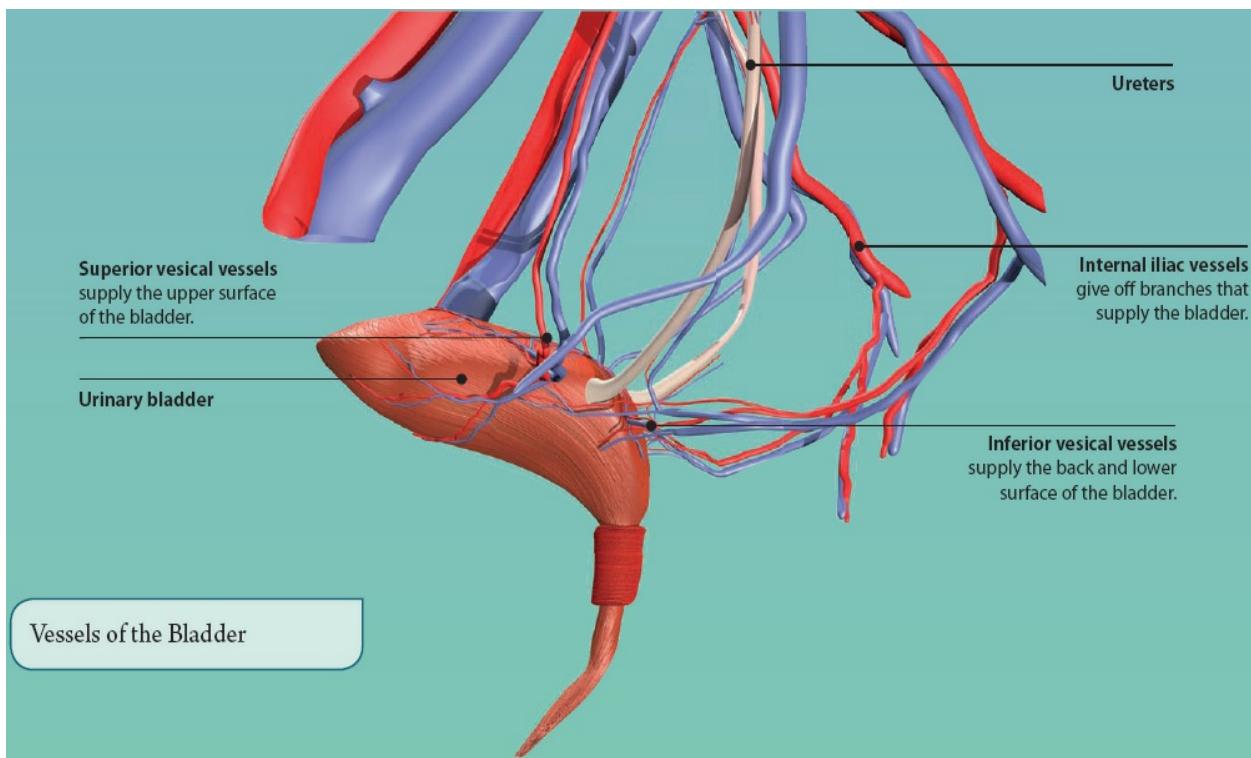
FEMALE BLADDER AND URETHRA

The urinary bladder is a muscular, expandable chamber found in the pelvis. It stores the urine formed by the kidneys until an appropriate place is found to expel it from the body.

The urethra transports urine from the bladder to the outside, in a process called urination.





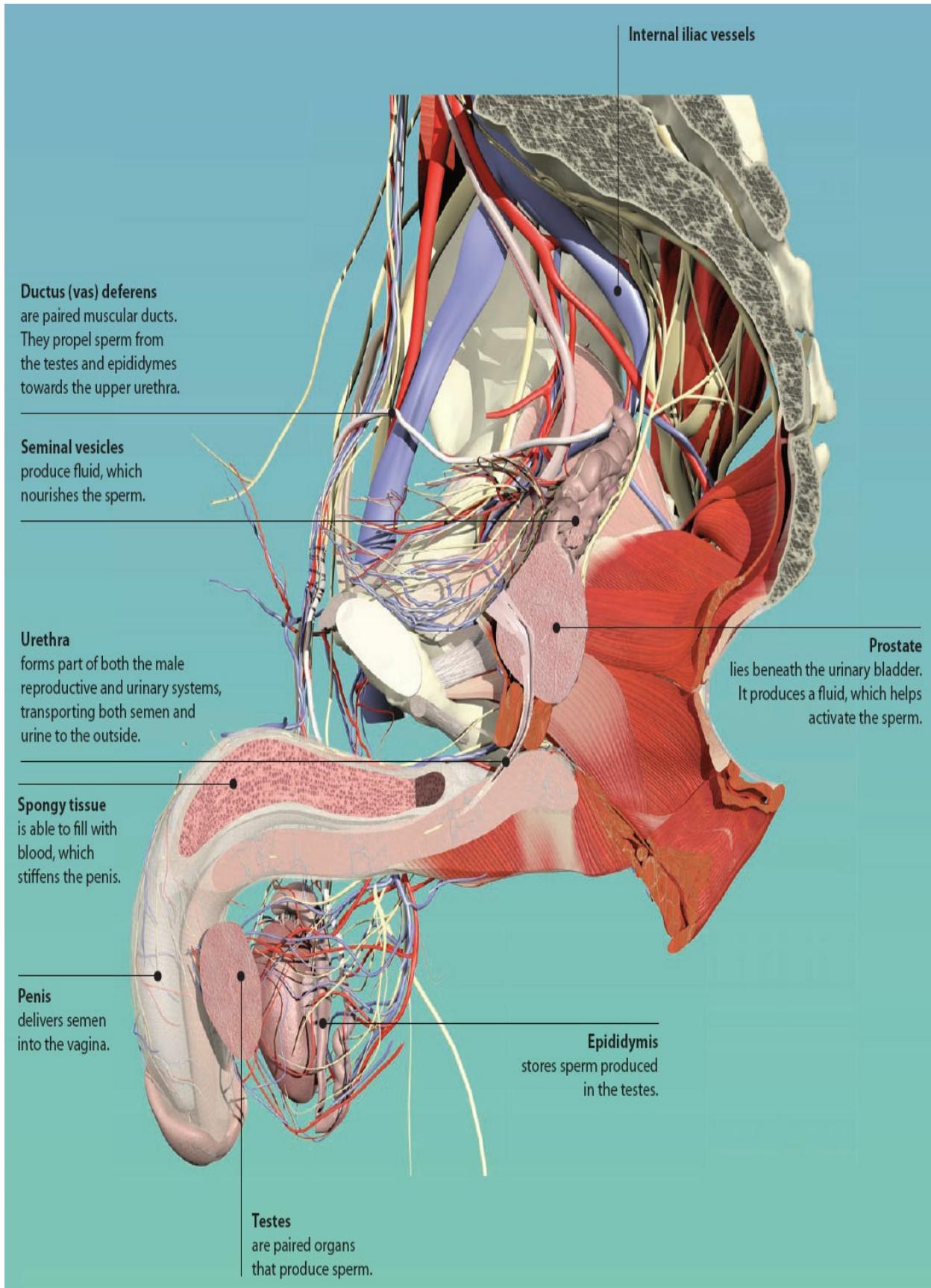


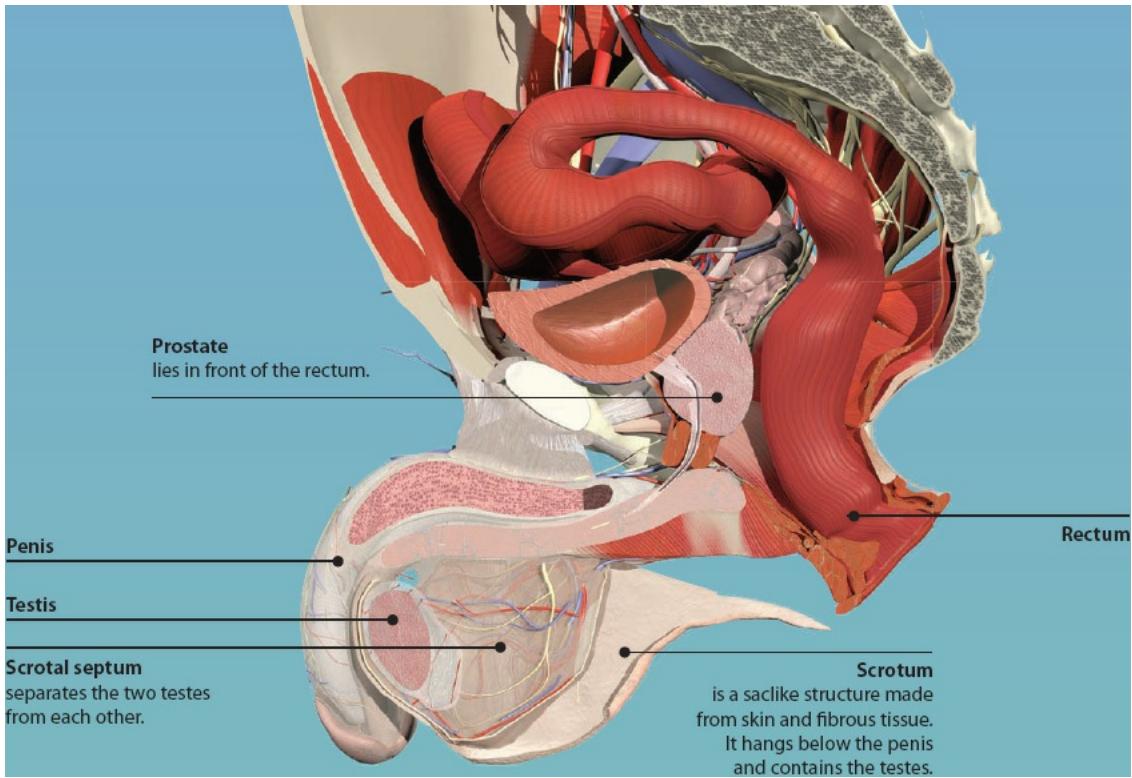
MALE REPRODUCTIVE SYSTEM

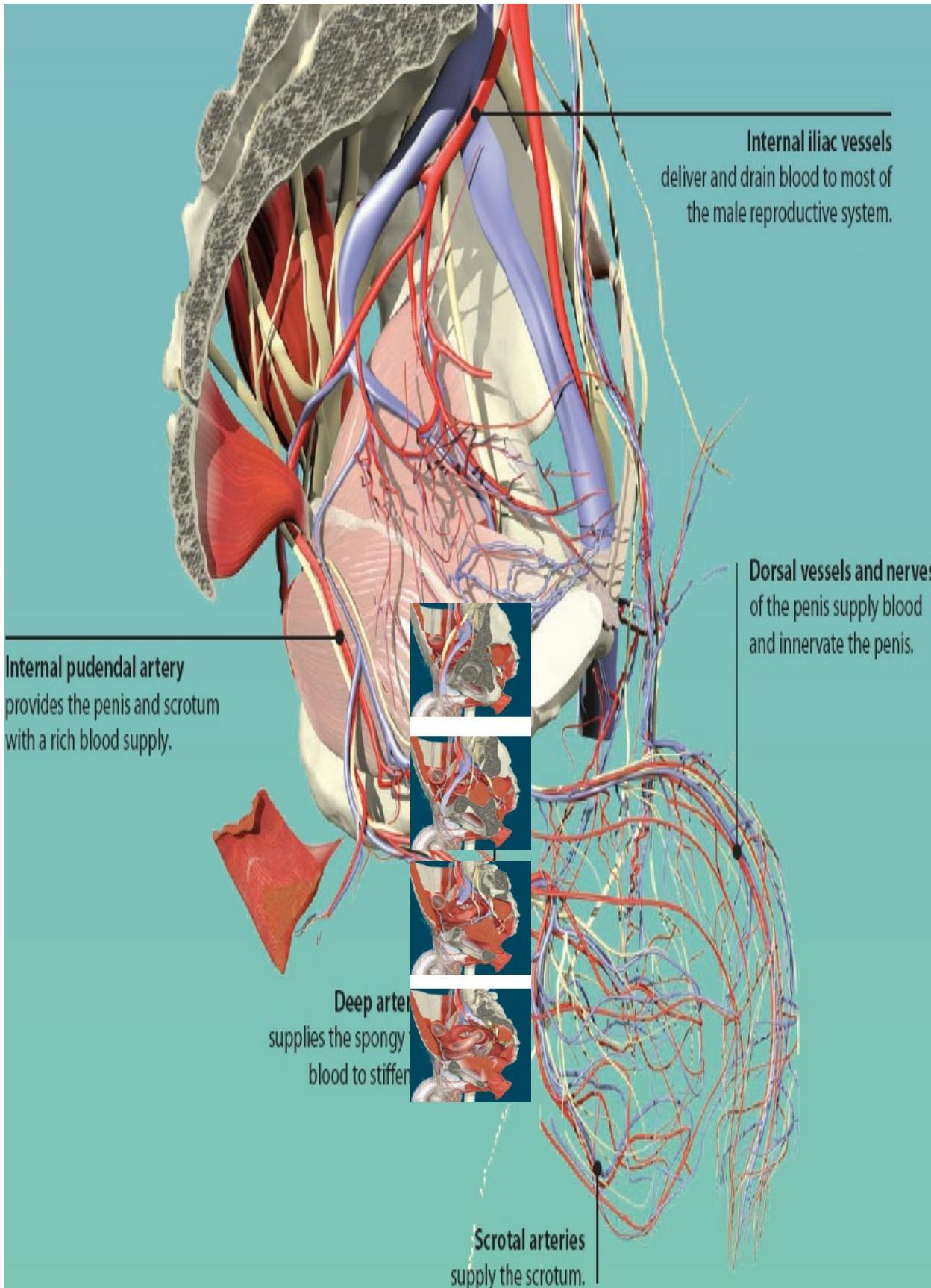
The male reproductive system includes the penis and testes, along with the ducts and glands that connect them. It produces, stores, matures, and delivers male sex cells called sperm. Sperm are suspended in fluids produced by the seminal vesicles and prostate to form semen.

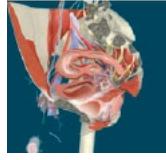
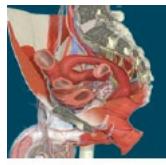
In an intimate act called sexual intercourse, the penis is inserted into the female vagina delivering semen into the female reproductive tract. If sperm meet a female sex cell (ovum) then fertilization takes place, and a new life starts to develop.

The male reproductive system produces hormones such as testosterone, which help with development all over the body.





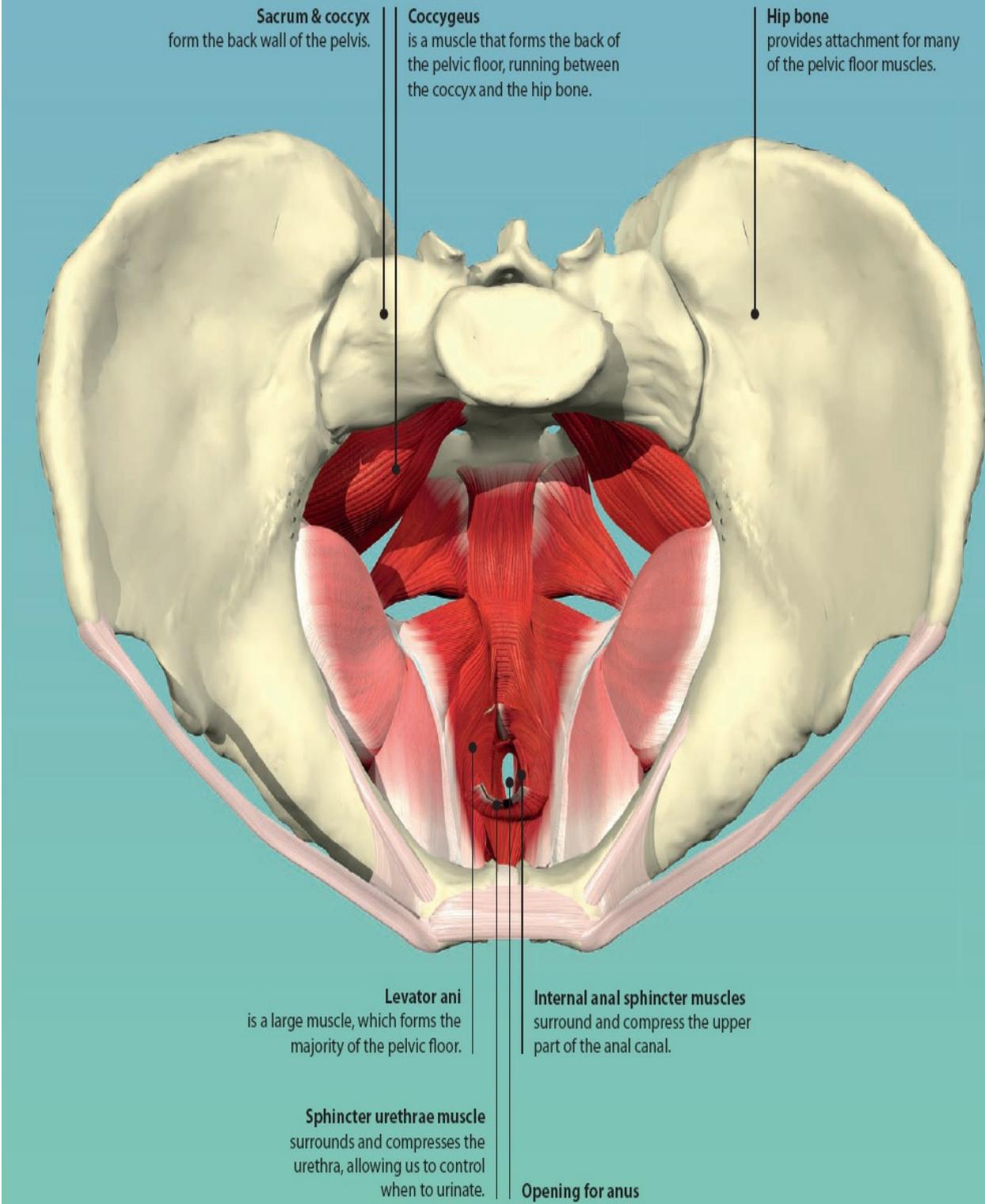




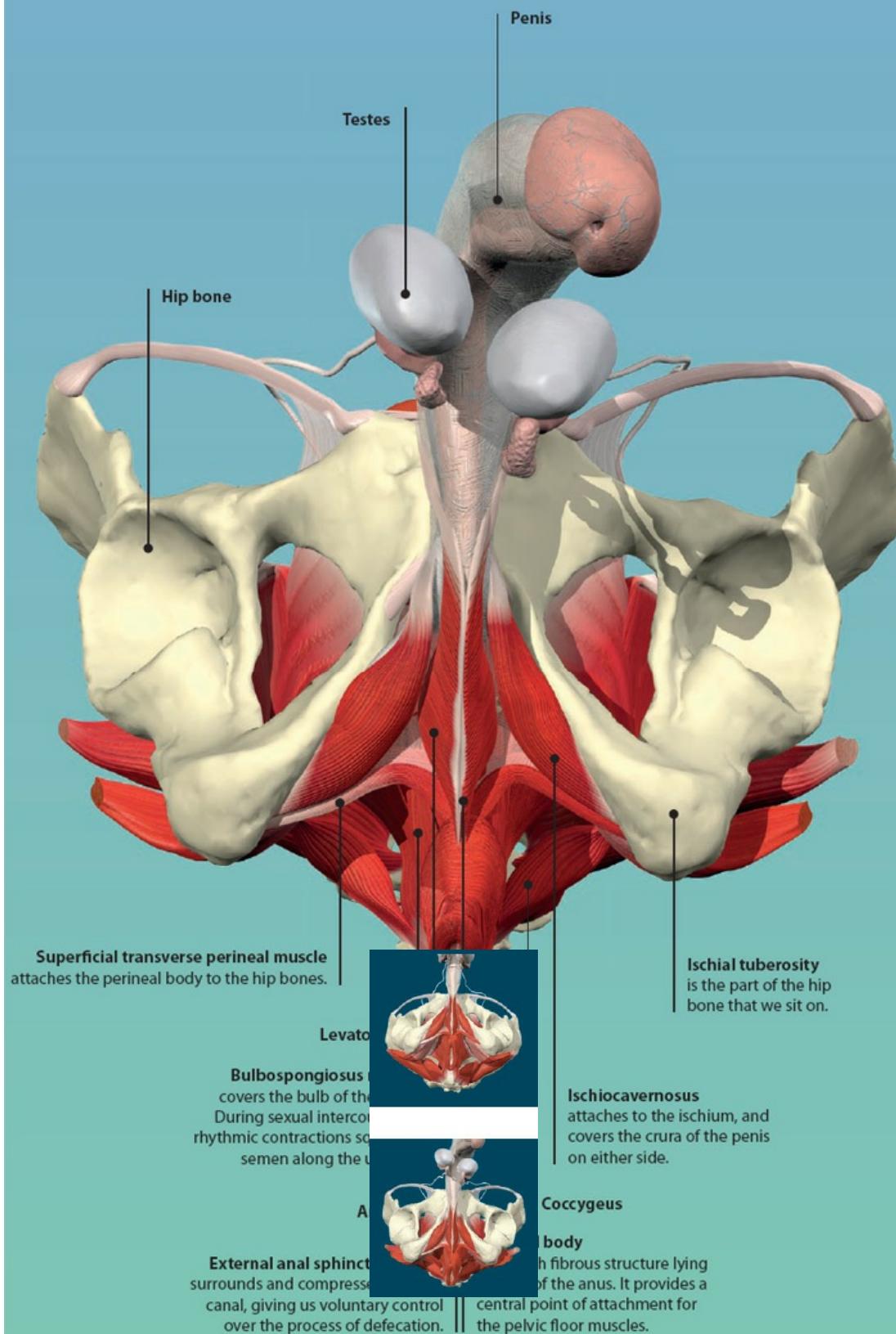
MALE PELVIC FLOOR

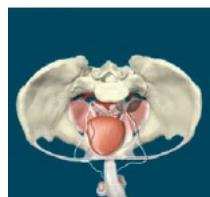
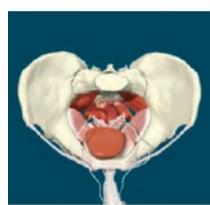
The pelvic floor is a muscular sheet that forms the base of the pelvic cavity. It is made up of numerous muscles, suspended from the pelvic bones. These form a hammocklike support for the pelvic organs. In the male it has openings for the urethra and anus.

Male Pelvic Floor: Superior Aspect



Male Pelvic Floor: Inferior Aspect

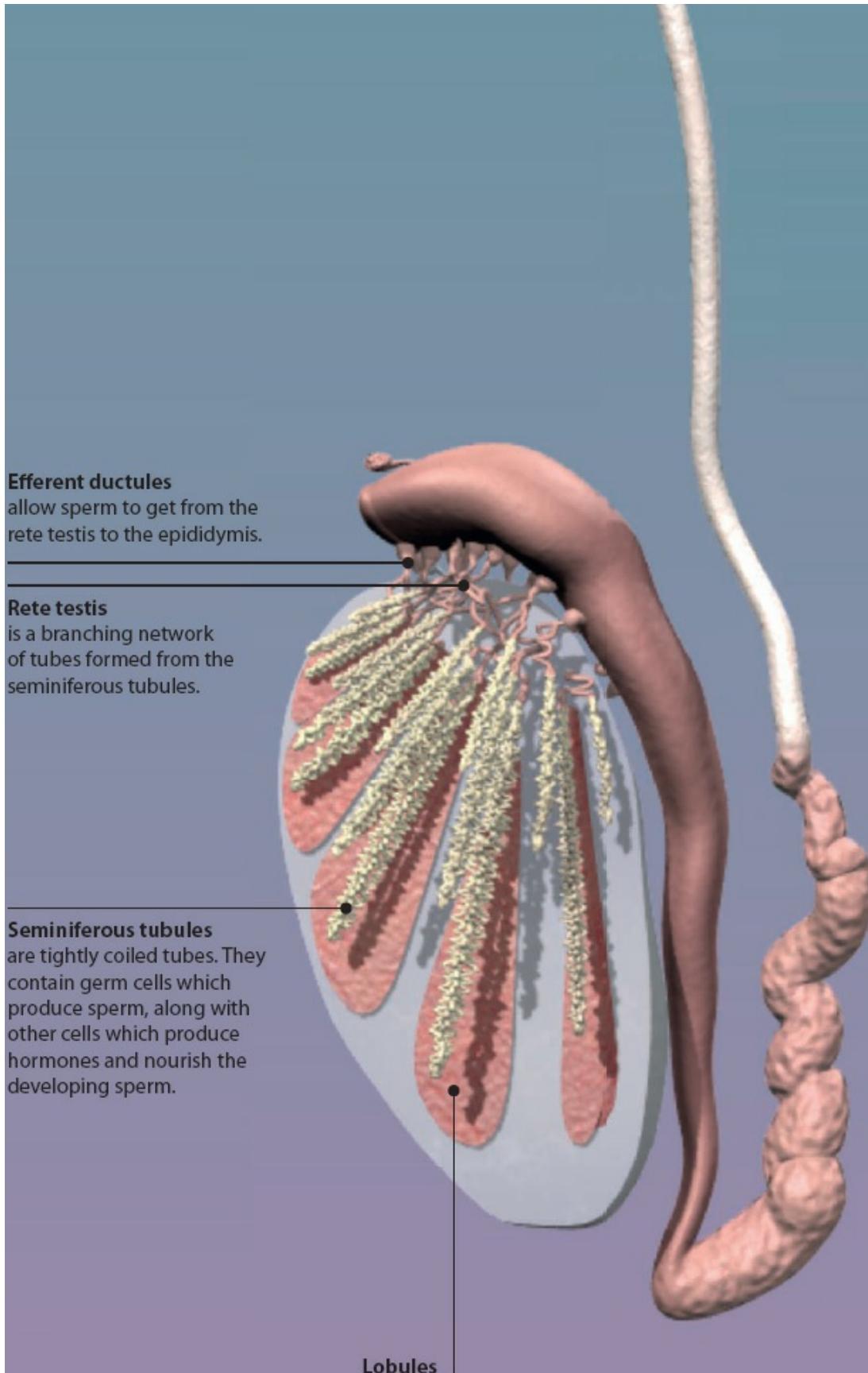


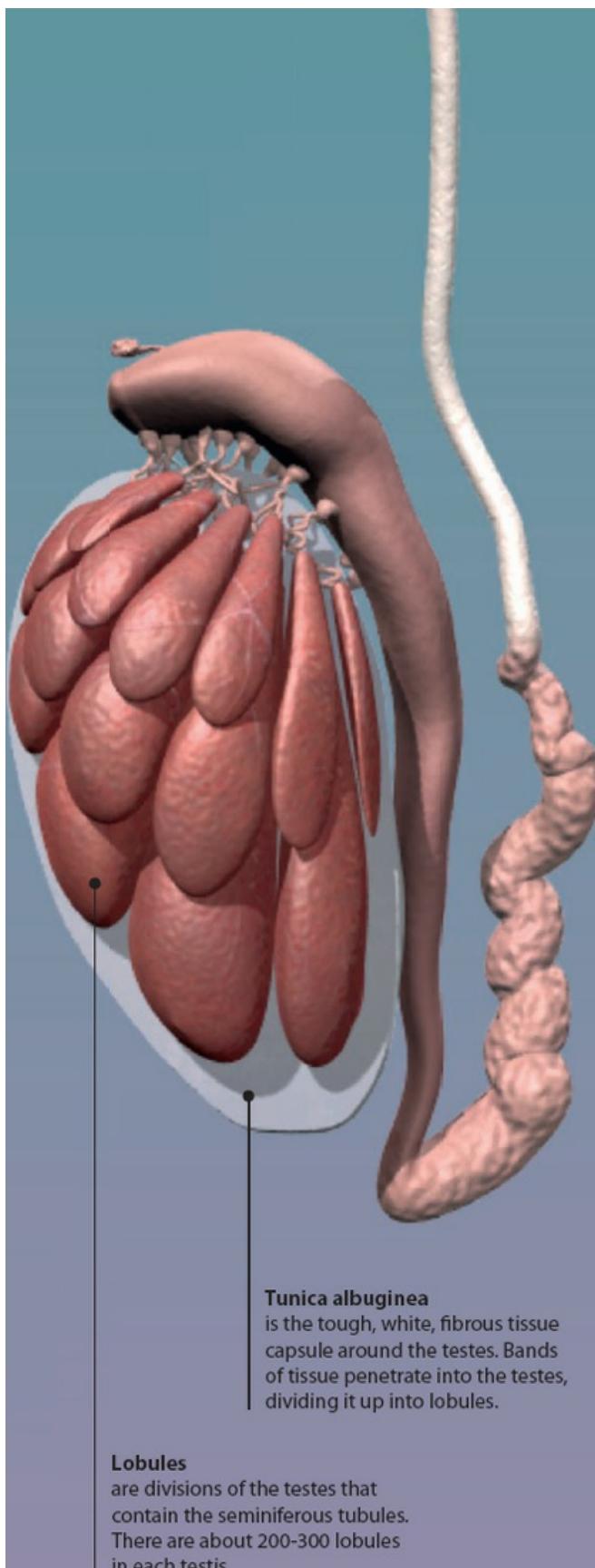


TESTES

The testes are the paired male reproductive glands. They are located within the scrotum, where they produce male sex cells, called sperm. Mature sperm are stored in the epididymis, until they are released in a process called ejaculation.

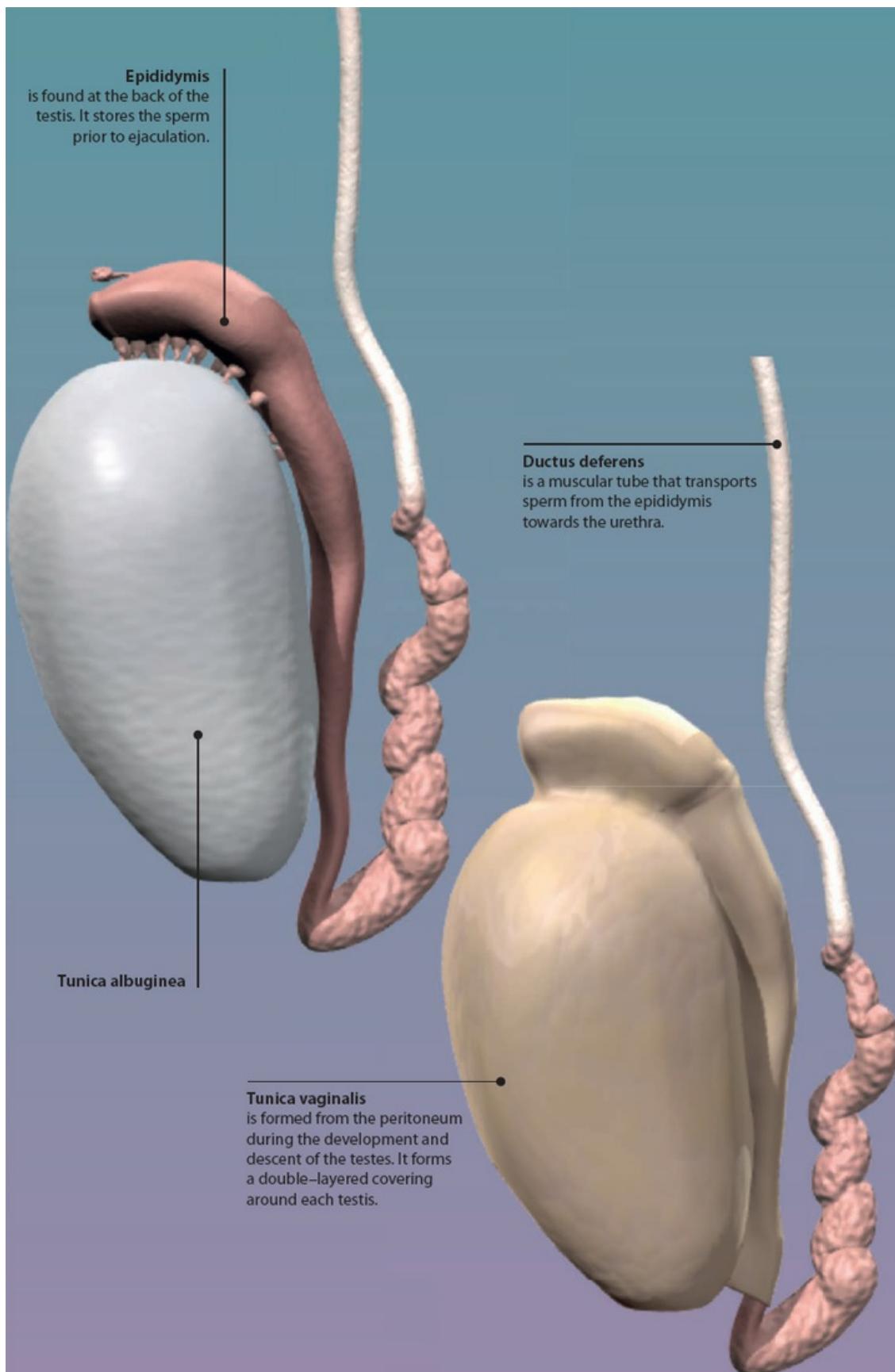
The testes originally develop near the kidneys. To reach the scrotum, they descend and pass through the abdominal wall. As they do so, they take with them a sac of peritoneum. This forms a covering around the testes known as the tunica vaginalis.





Tunica albuginea
is the tough, white, fibrous tissue capsule around the testes. Bands of tissue penetrate into the testes, dividing it up into lobules.

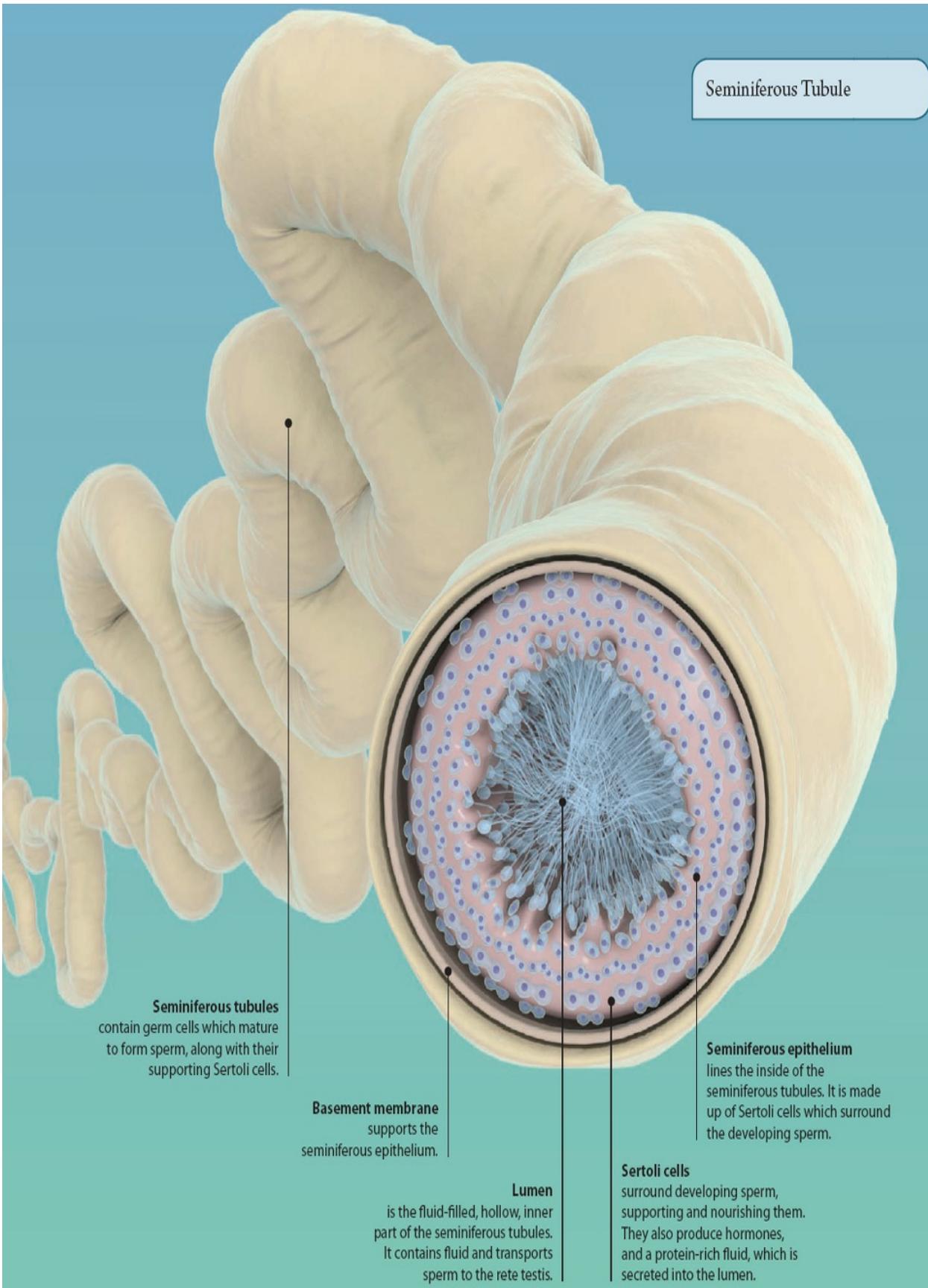
Lobules
are divisions of the testes that contain the seminiferous tubules.
There are about 200-300 lobules in each testis.

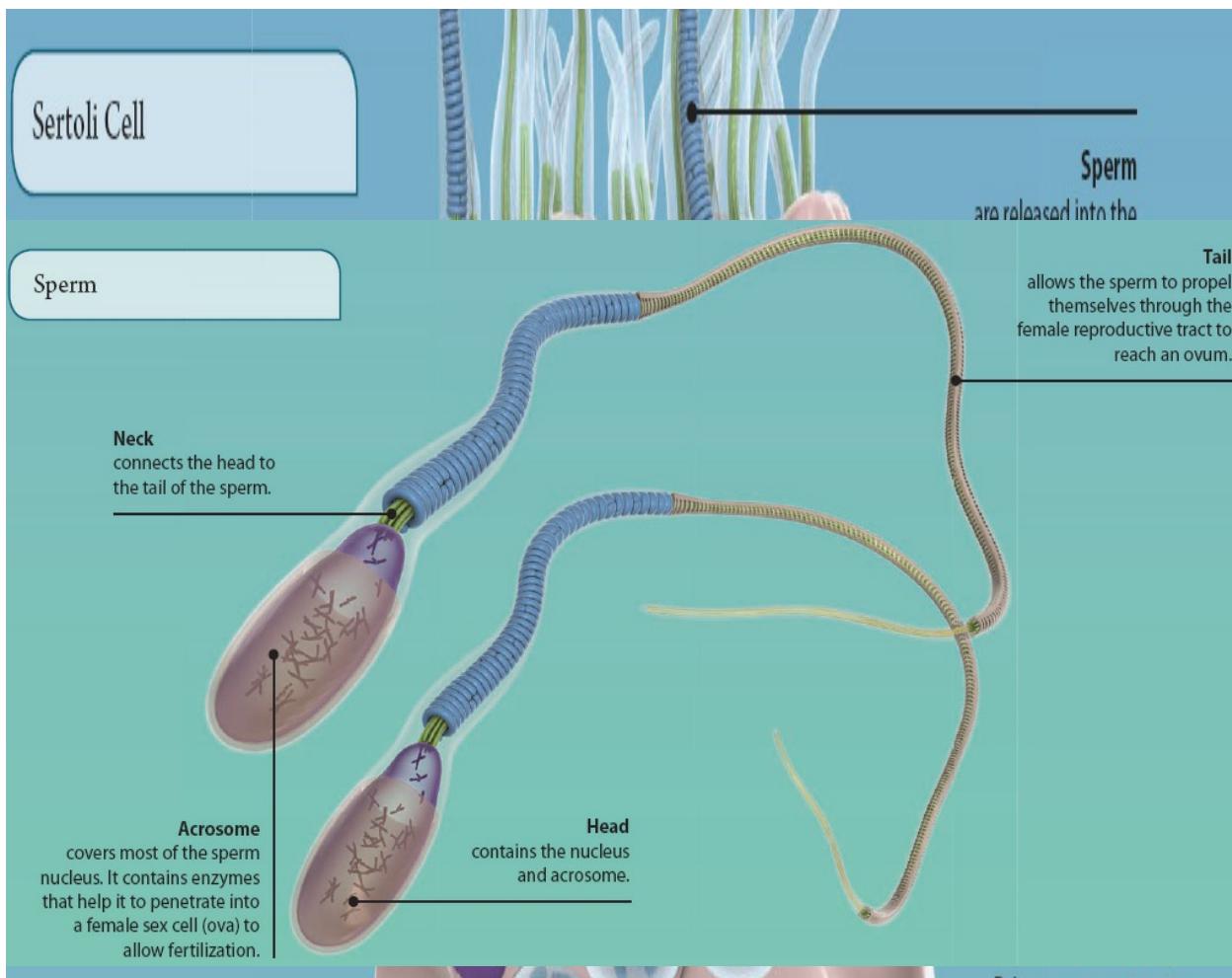




SPERMATOGENESIS

Spermatogenesis is the process by which the male sex cells, called sperm, are formed. It occurs in the lining cells of the tightly coiled seminiferous tubules, located within the testes. After puberty, approximately 300 million sperm are produced in the testes each day.





SPERMATIC CORD AND SCROTUM

Spermatogenesis occurs best at temperatures slightly lower than body temperature. Due to this, the testes are suspended outside the body within the thin-skinned, saclike scrotum.

During development, as the testes descend from the abdomen into the scrotum, they pass through the abdominal wall. As they do so, they are covered by three layers of tissue called fascia. The testicular blood vessels, and ductus deferens are also lined by these fascia layers to form the spermatic cords.

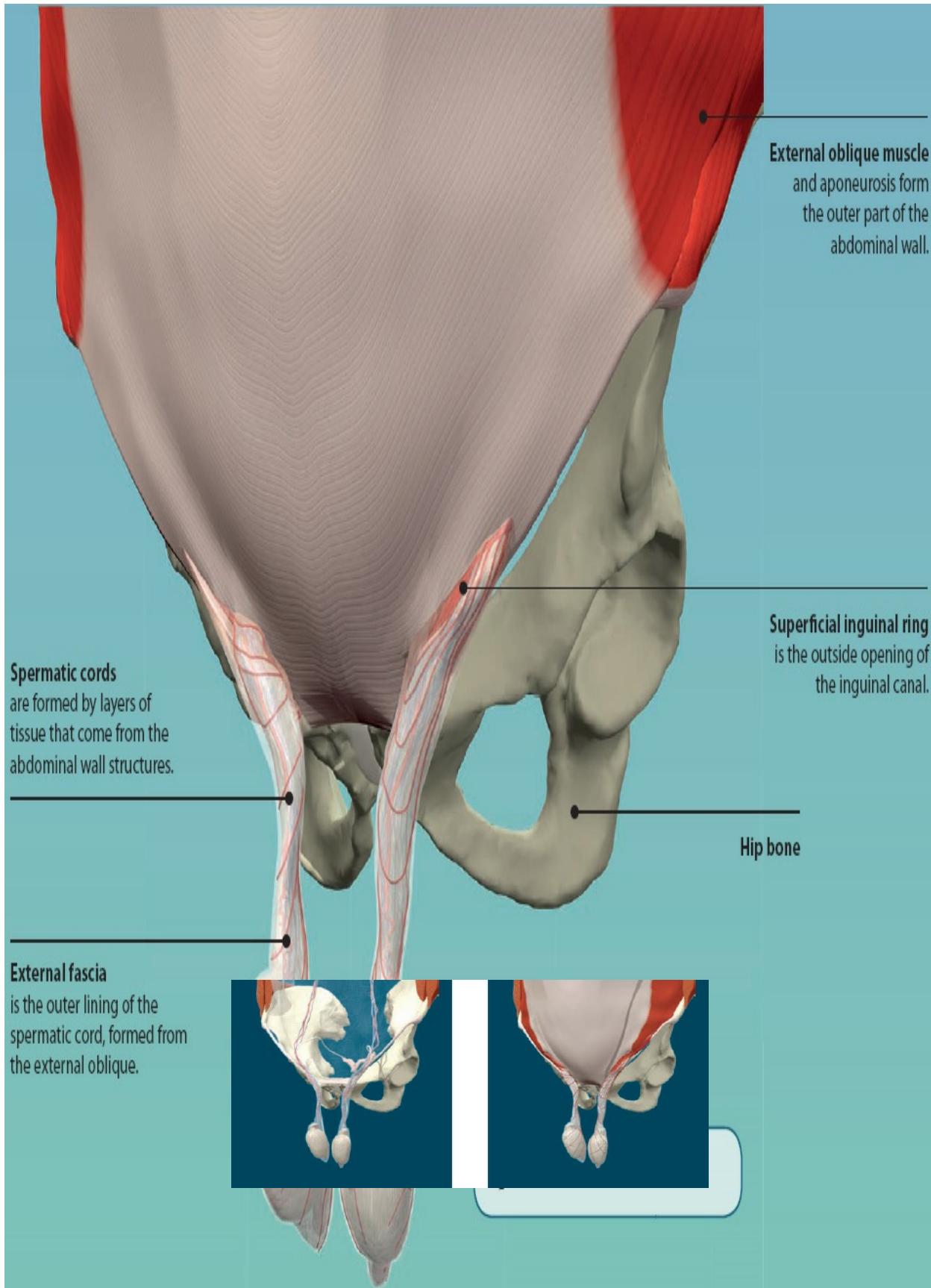
The short angled passageway through the abdominal wall is called the inguinal canal.
Spermatogonia are the germ cells which divide to provide a constant supply of developing male sex cells (sperm). They are found on top of the basement membrane.

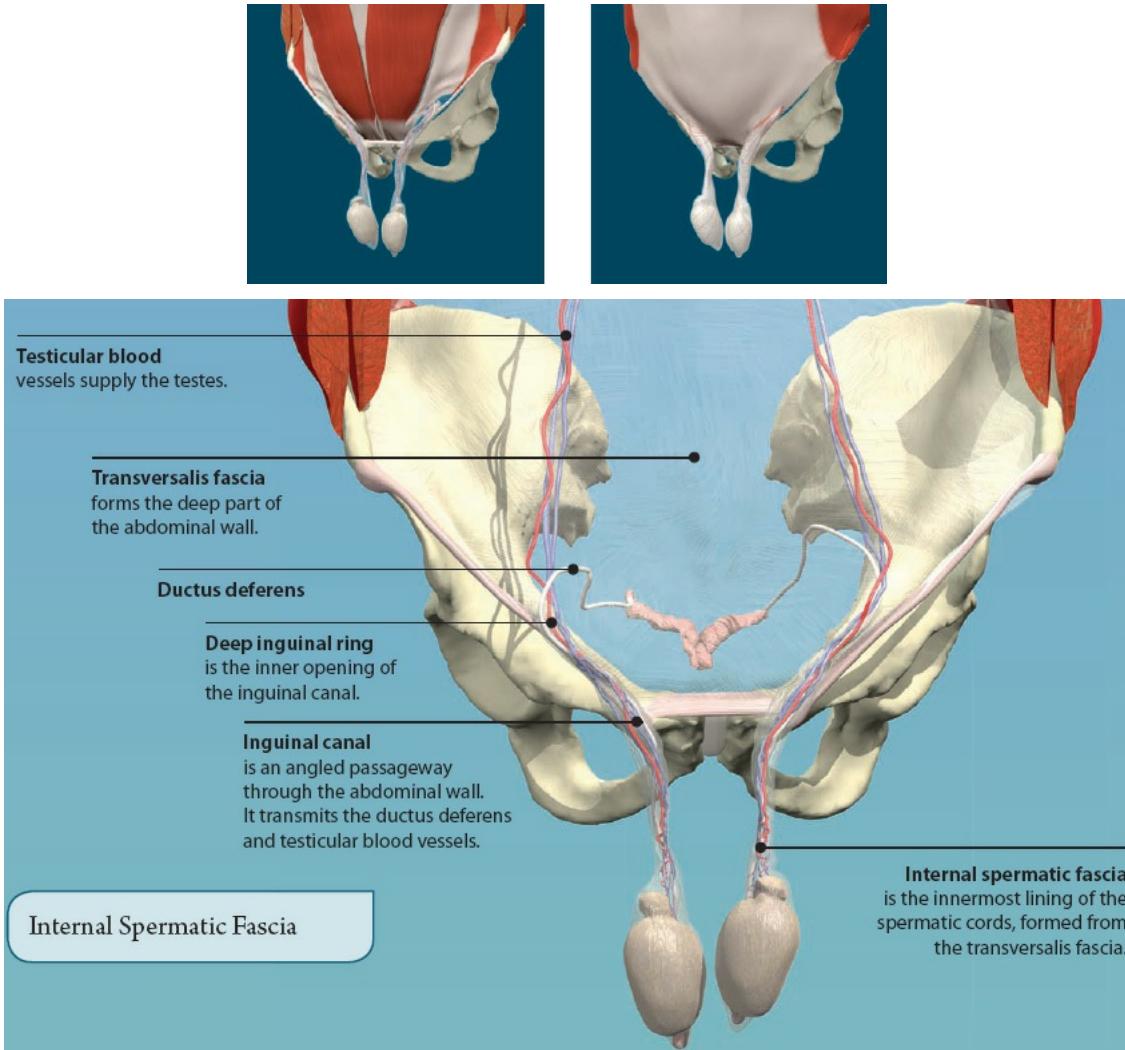
Primary spermatocytes
are formed from
spermatogonia and are
found closer to the lumen.

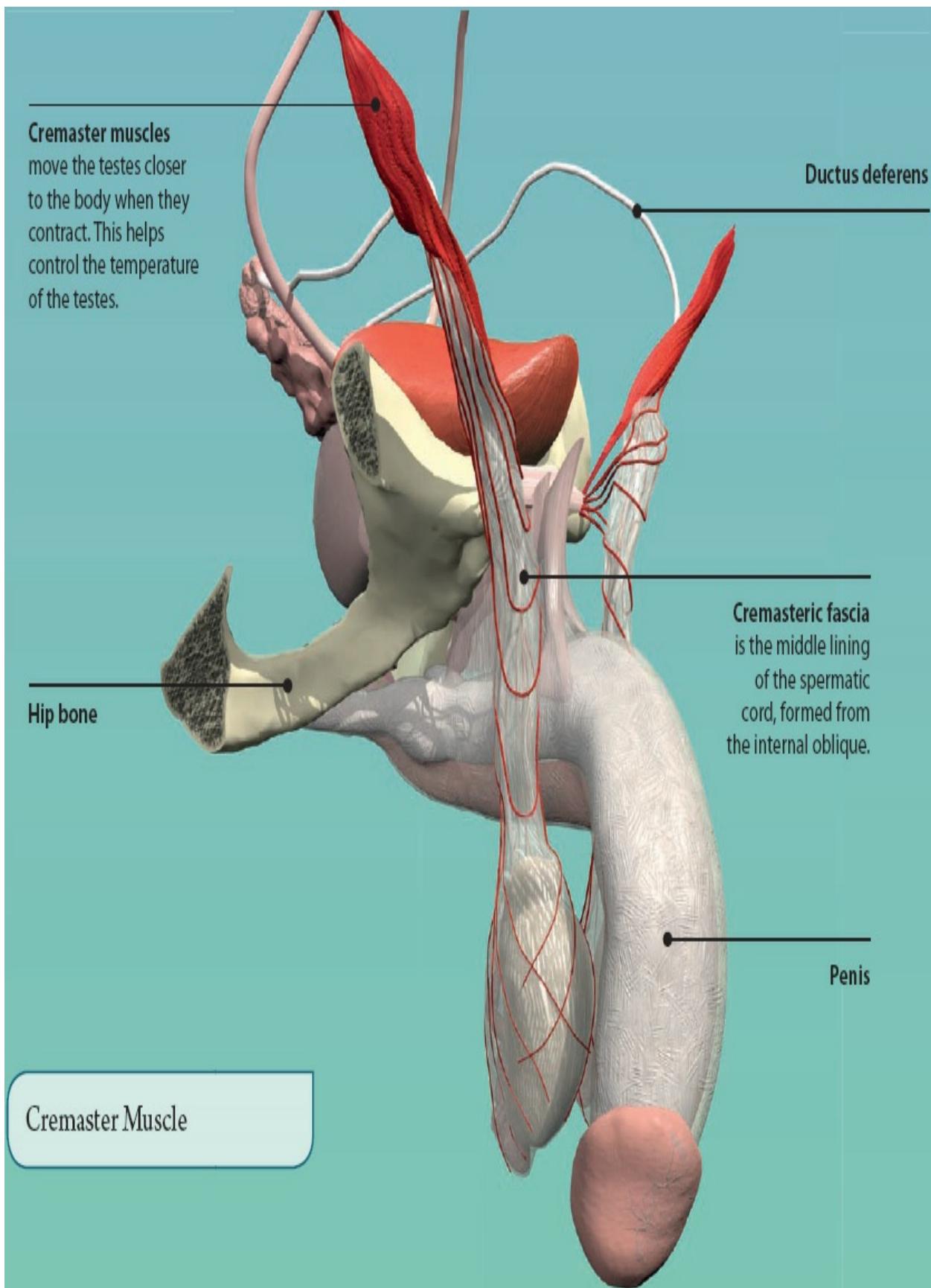
Sertoli cell

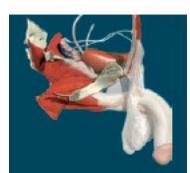
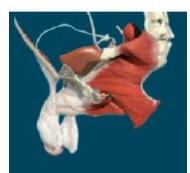
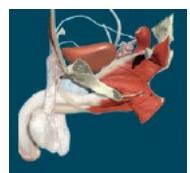
Basement membrane











SPERMATIC DUCTS AND GLANDS

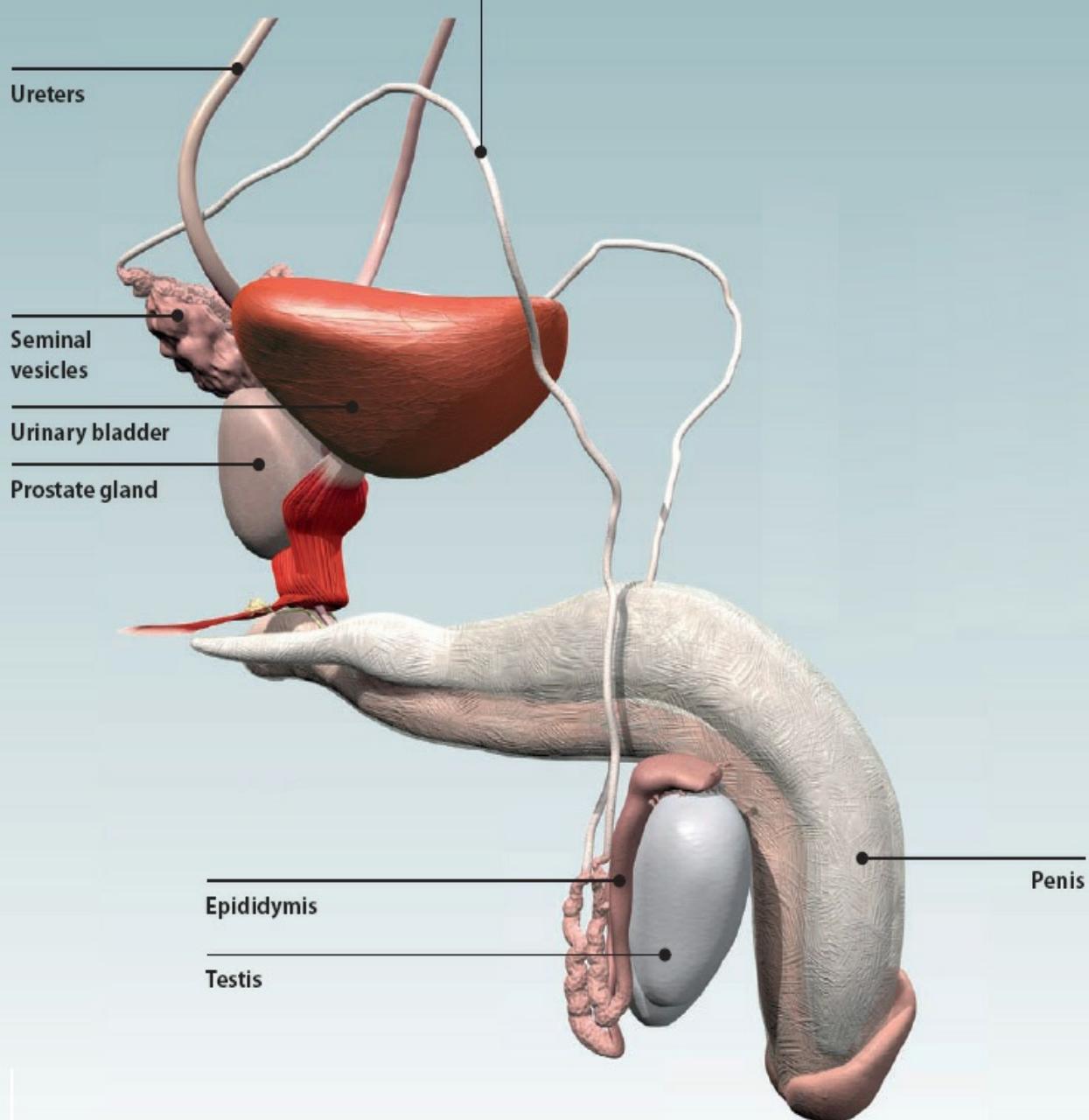
The epididymis, ductus deferens, and ejaculatory ducts are responsible for the storage and transport of sperm from the testes to the urethra.

The accessory glands consist of the seminal vesicles, prostate gland, and bulbourethral glands. Together, they produce seminal fluid, which nourishes the sperm. The mixture of sperm and seminal fluid is known as semen.

Ductus Deferens

Ductus deferens

is a long, thin, muscular tube that transports sperm from the epididymis to the ejaculatory ducts. It travels in the spermatic cord and through the inguinal canal, before joining with ducts draining the seminal vesicles to form the ejaculatory ducts.

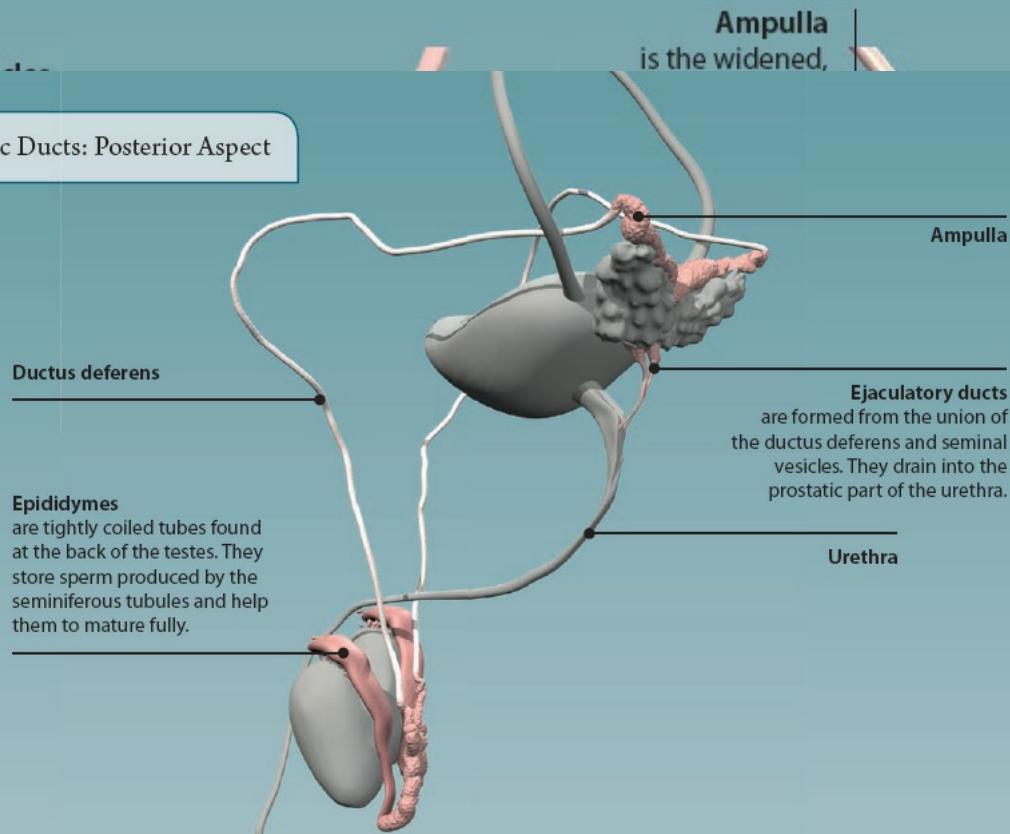


Seminal Vesicles

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Spermatic Ducts: Posterior Aspect



improve the mobility and survival of sperm. The ejaculatory ducts and part of the urethra run through the prostate gland.

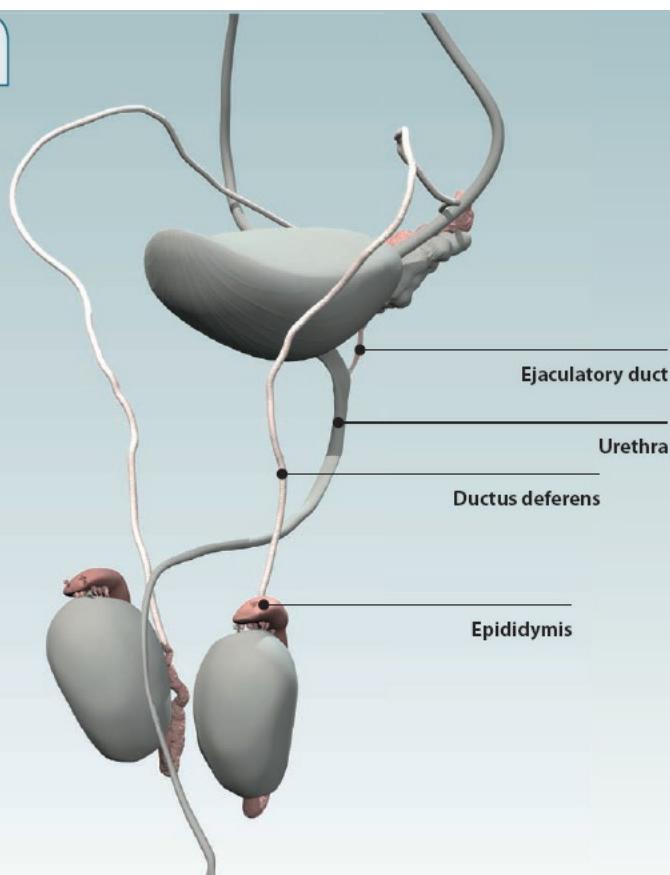
Penis

Epididymes

Testis

Bulbourethral glands are found at the base of the penis. They produce a natural lubricating fluid.

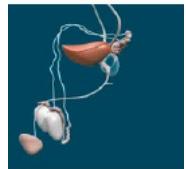
Spermatic Ducts: Anterior Aspect



Did you know?

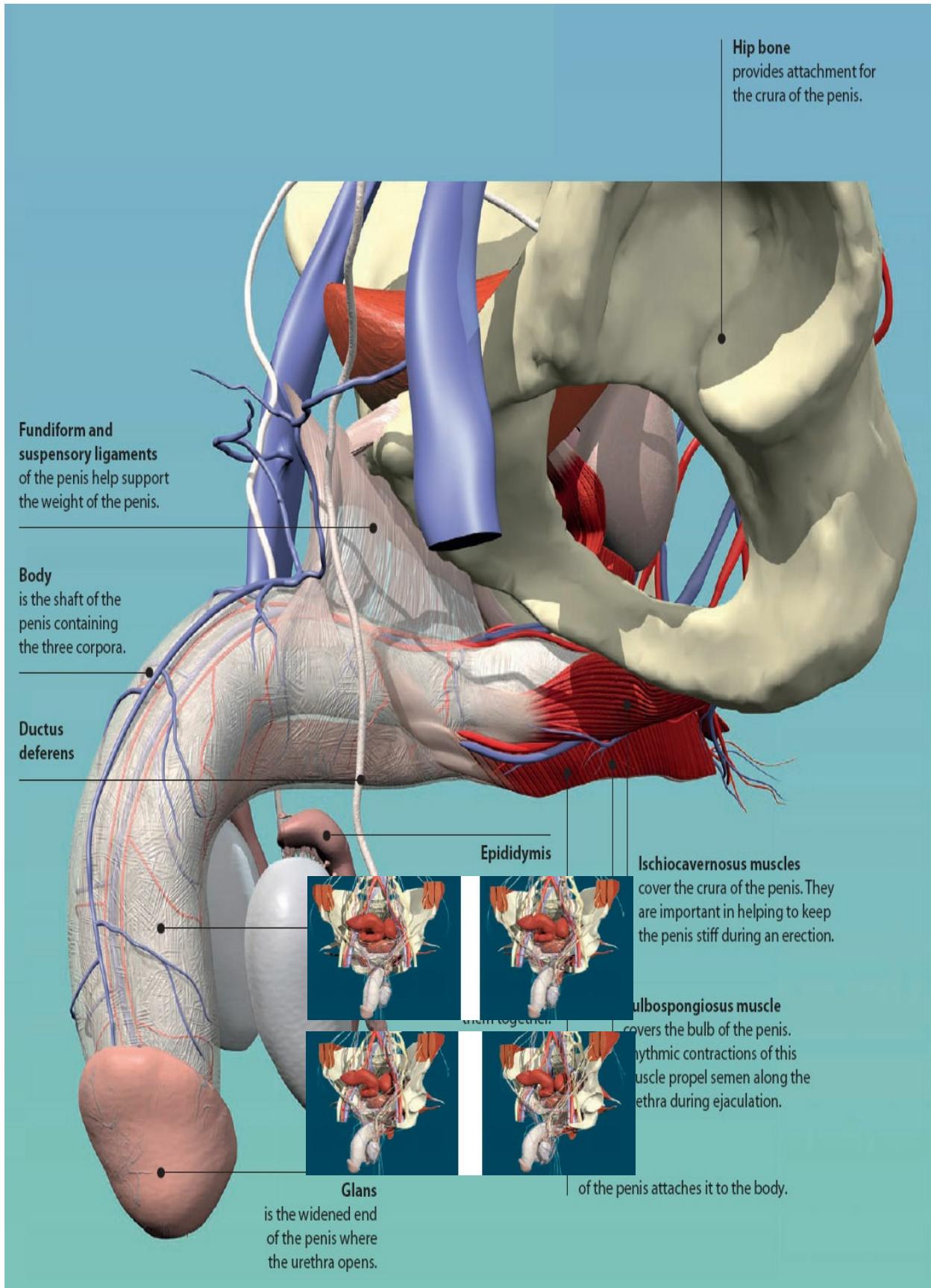
The ductus deferens is also known as the vas deferens. A vasectomy is a minor surgical procedure where a short section of the ductus deferens is removed. This prevents sperm produced in the testis from reaching the ejaculatory ducts or urethra, and prevents fertilization of an egg during sexual intercourse.

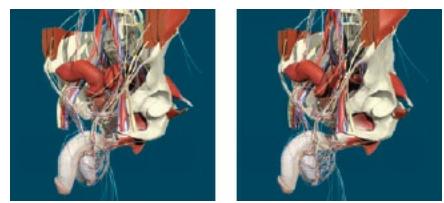


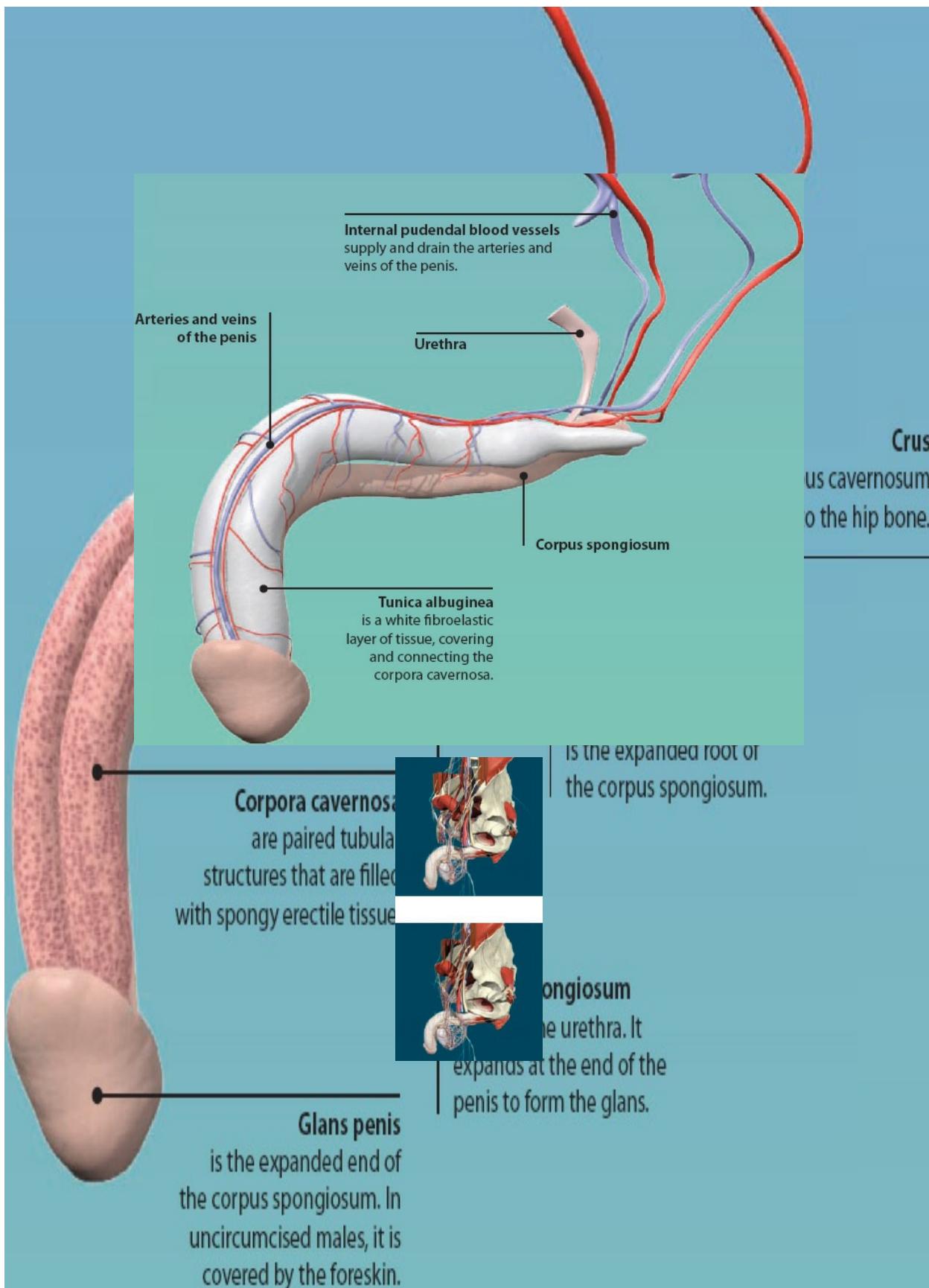


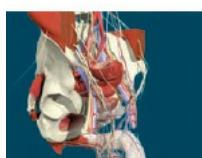
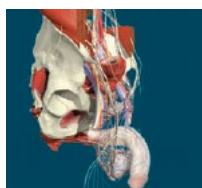
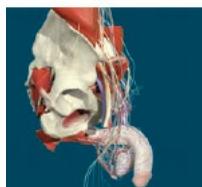
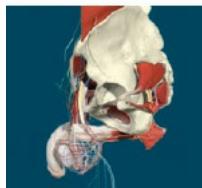
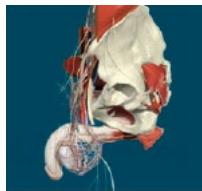
PENIS

The penis is a cylindrical organ that allows semen to be delivered into the vagina during sexual intercourse, and also provides an outlet for urine. It is made up of three tubular structures (corpora), with the urethra running along its length. The penis can be made stiff by filling the corpora with blood, leading to an erection.





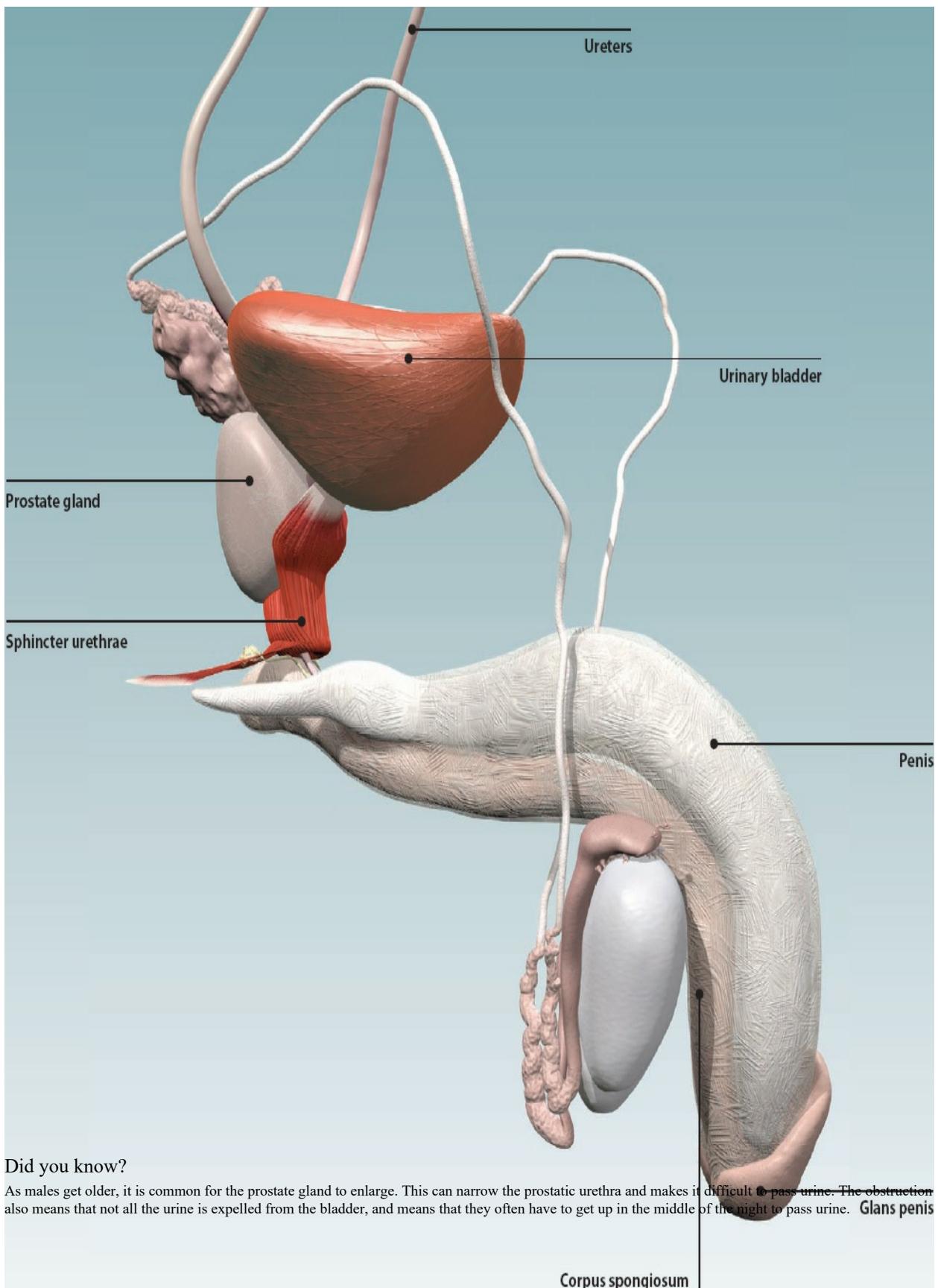




MALE BLADDER AND URETHRA

The urinary bladder is a muscular, expandable chamber found in the pelvis. It stores the urine formed by the kidneys until an appropriate place is found to expel it from the body.

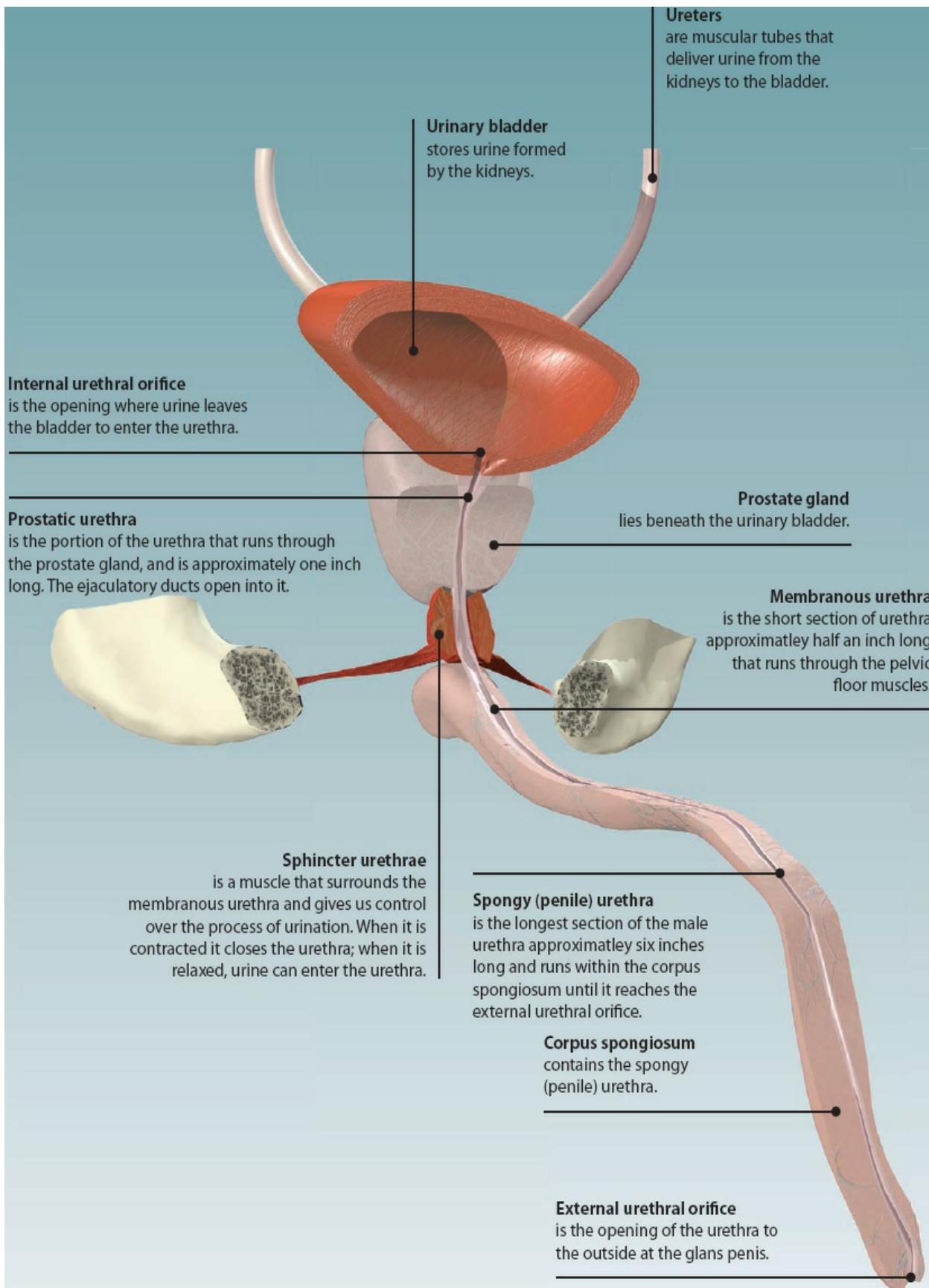
The urethra is a muscular tube that connects the urinary bladder to the outside. In the male it is an outlet for both urine and semen, and is much longer than the female urethra (approximately eight inches long). It is divided into three sections: prostatic, membranous, and spongy (penile).

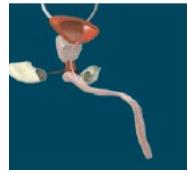


Did you know?

As males get older, it is common for the prostate gland to enlarge. This can narrow the prostatic urethra and makes it difficult to pass urine. The obstruction also means that not all the urine is expelled from the bladder, and means that they often have to get up in the middle of the night to pass urine. **Glans penis**

Corpus spongiosum

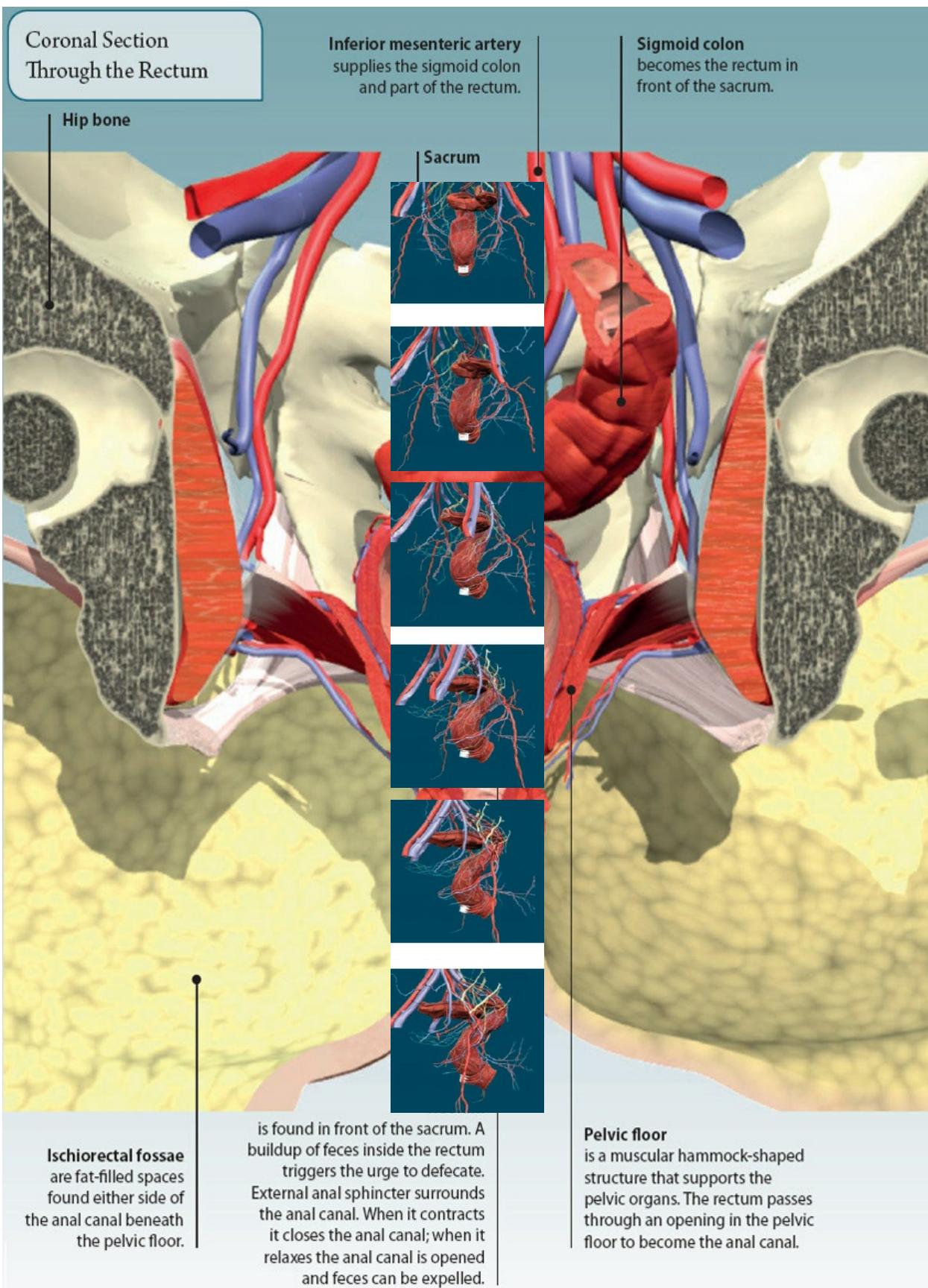


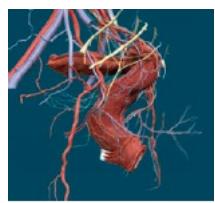


RECTUM

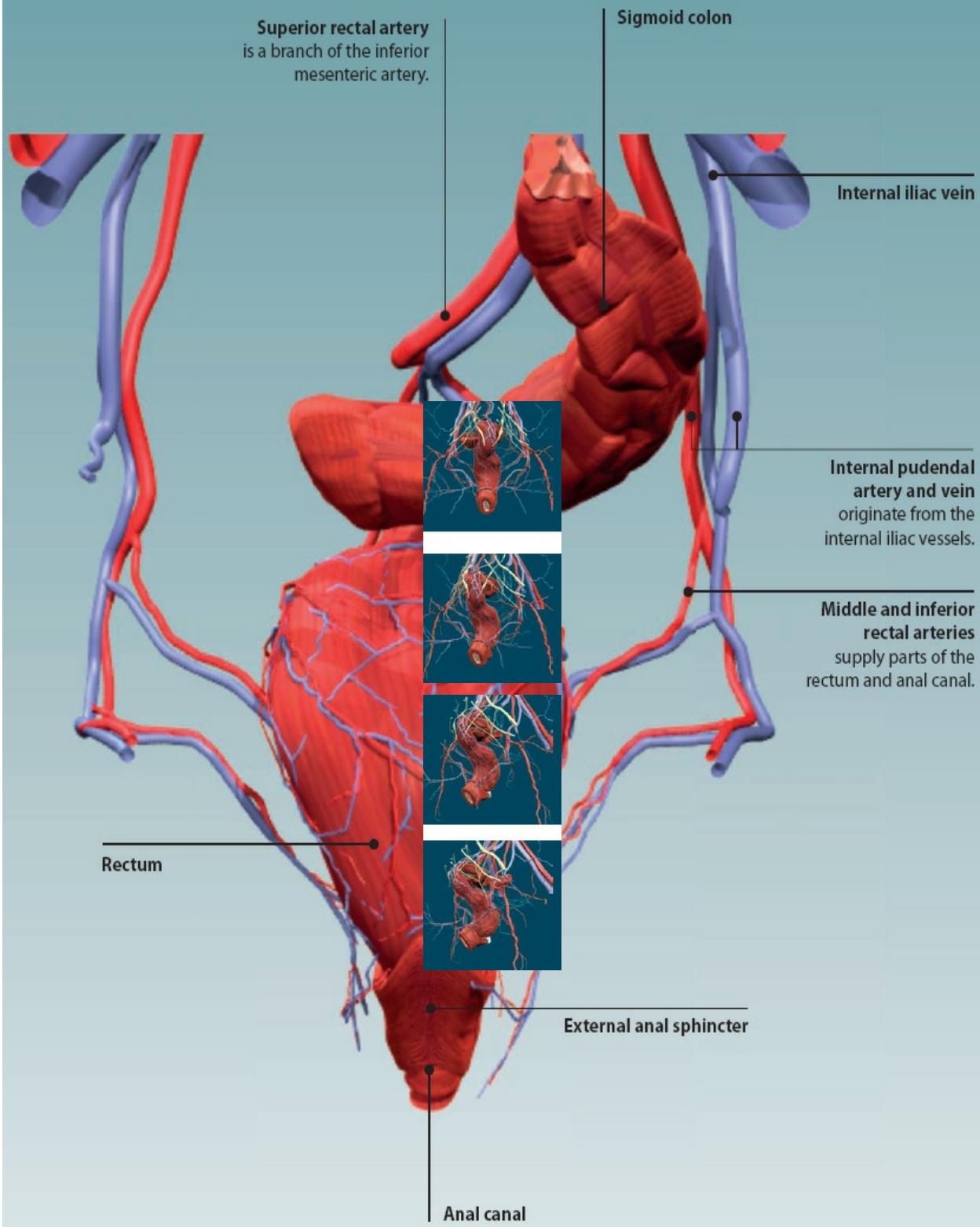
The rectum and anal canal are the final sections of the digestive system. The rectum is located in the pelvis in front of the sacrum, and is a continuation of the sigmoid colon. It is about five inches long, and passes through the pelvic floor muscles to become the anal canal. The rectum and anal canal are involved in the process of defecation, where feces are expelled from the body.

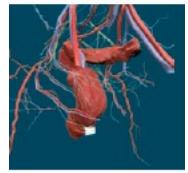
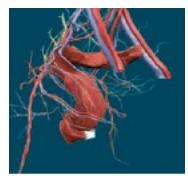
Coronal Section Through the Rectum





Blood Supply to the Rectum



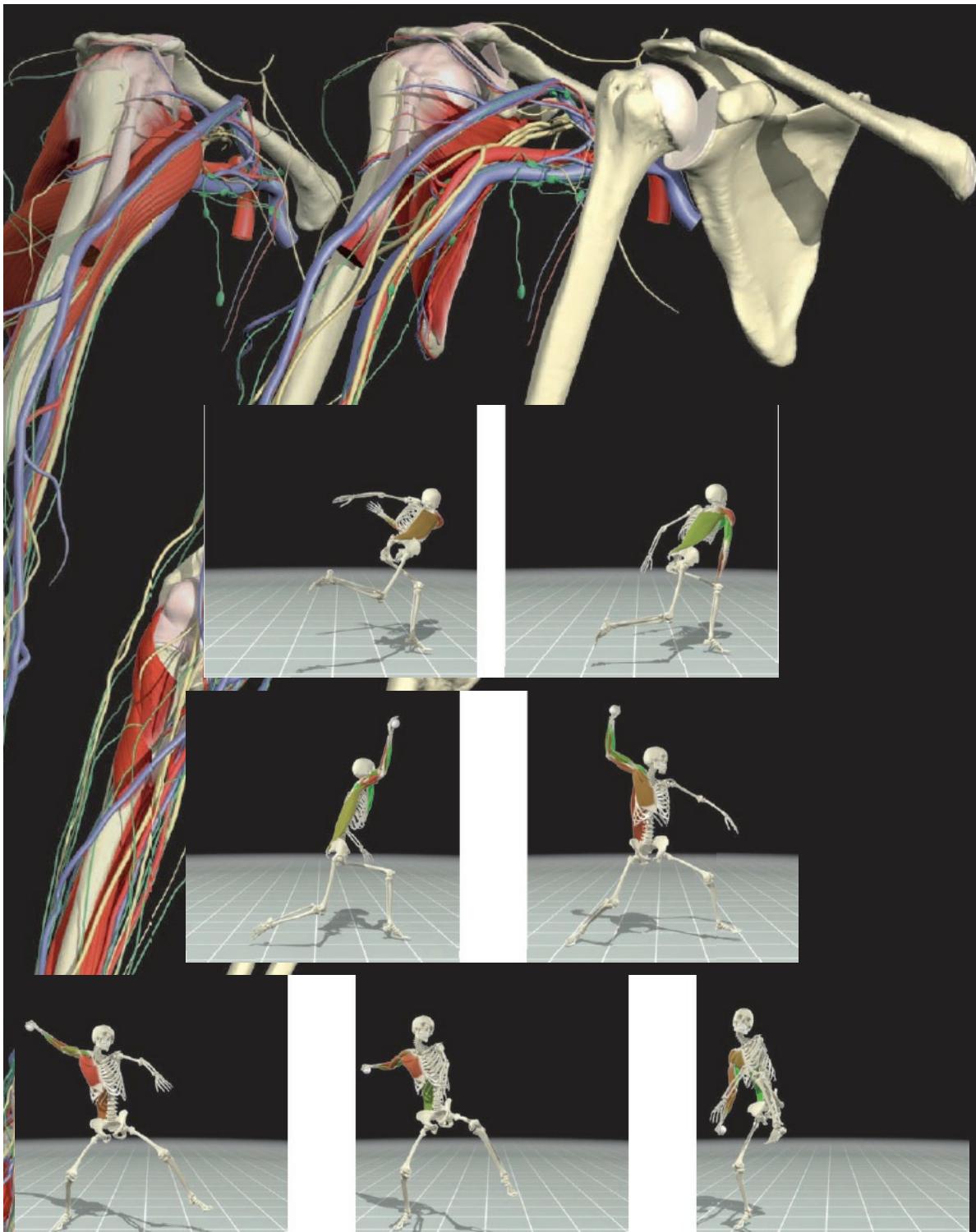


CHAPTER 7: THE UPPER LIMB

The two upper limbs are attached to the trunk by the shoulder girdle. This is formed by the collar bones (clavicle) and shoulder blades (scapula). Each upper limb can be divided into four main regions: the shoulder, arm, forearm, and hand.

Movements of the shoulder and elbow joints position the hand precisely in space, so that it can carry out a wide range of functions. These vary from the delicate, coordinated actions required to tie shoe laces, through to gripping, lifting, moving, and throwing objects. The hand also has numerous sensory receptors, which allow us to tell the difference between objects just on the basis of touch.

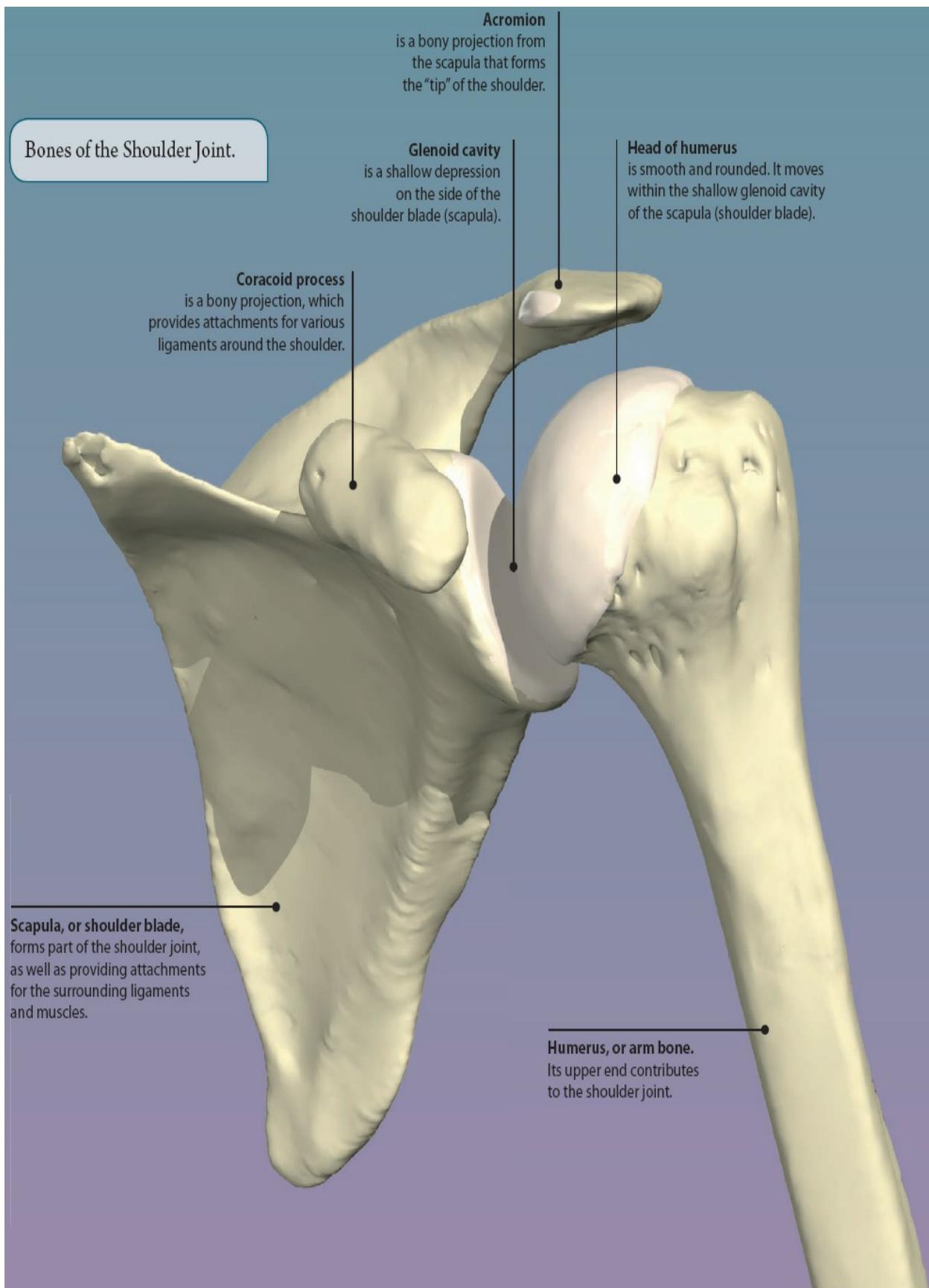




SHOULDER JOINT

The shoulder is an example of a ball and socket joint. It is formed by the rounded head of the humerus (arm bone) moving within the glenoid cavity of the scapula (shoulder blade). It is the most mobile joint in the body, capable of a

wide range of movements. Strong ligaments and muscles help to make the joint stable.



Ligaments of the Shoulder Joint

Acromioclavicular ligament

Coracoclavicular ligament

Coracoacromial ligament

Transverse humeral ligament

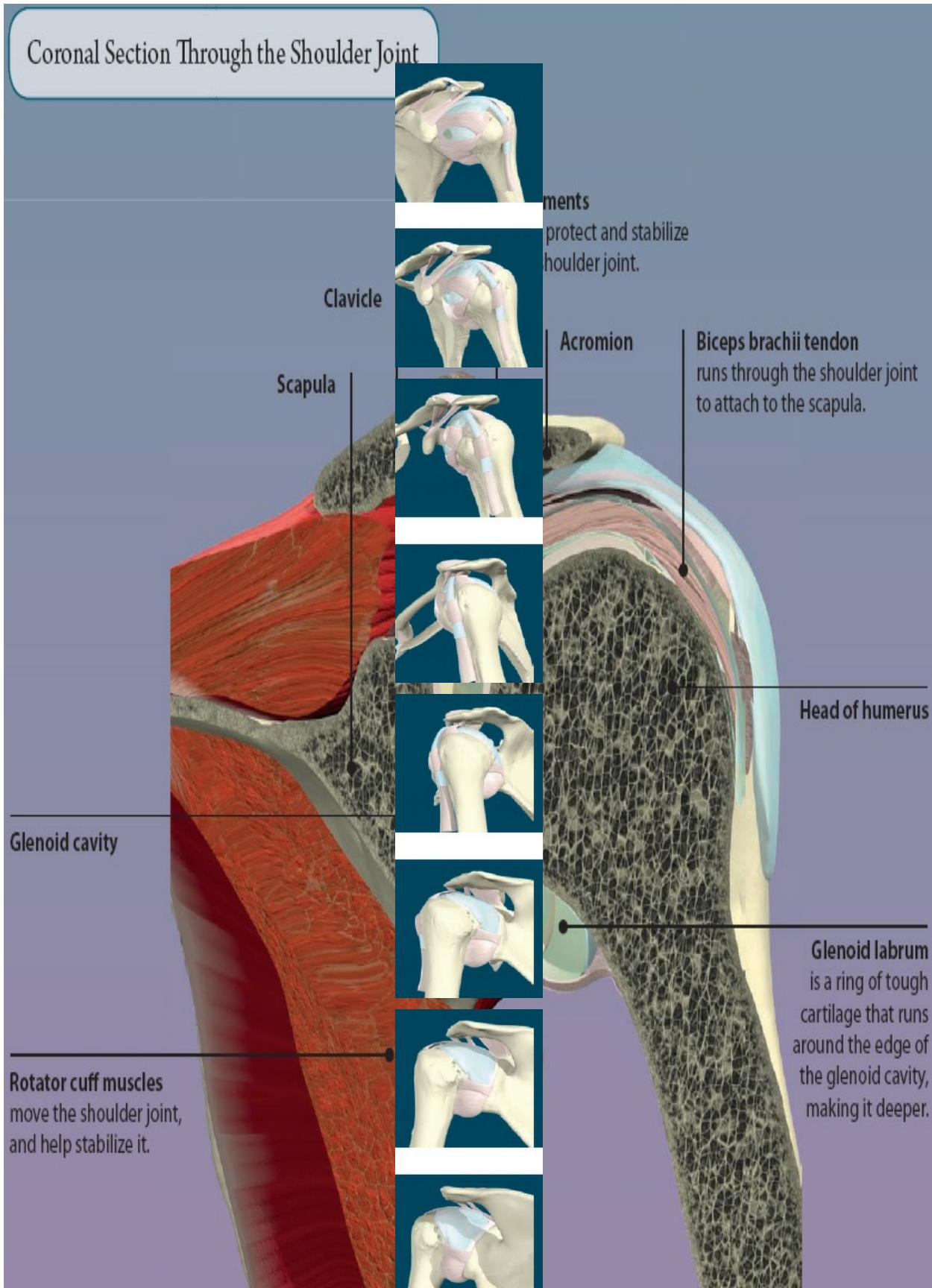
Biceps brachii tendon

Glenohumeral
ligaments
reinforce the
joint capsule.

First rib

Clavicle (or collar bone)
forms part of the shoulder
girdle, attaching the
upper limb to the trunk.

Coronal Section Through the Shoulder Joint

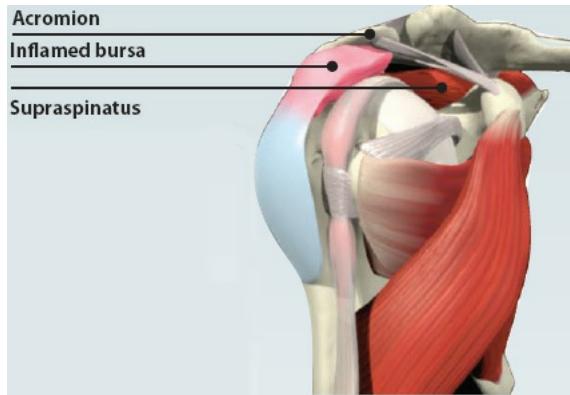


MUSCLES OF THE SHOULDER

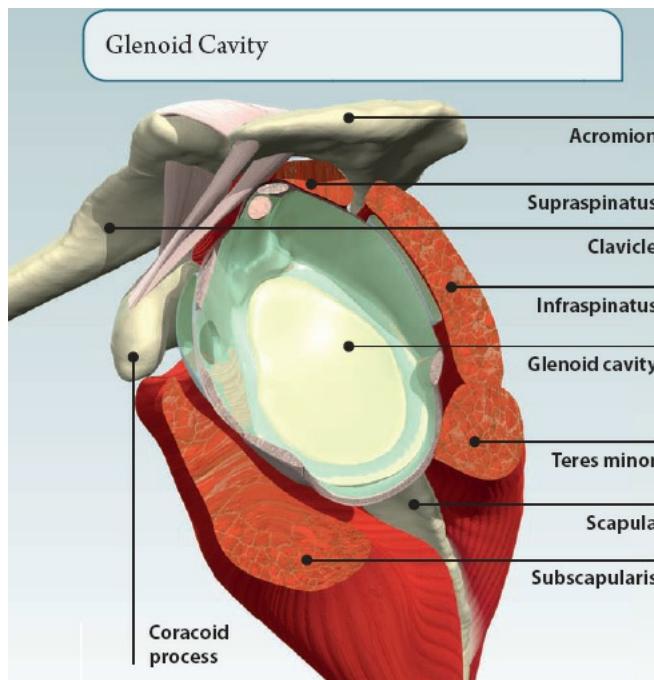
The shoulder is the region of the upper limb that attaches it to the trunk. It contains the highly mobile shoulder joint. Muscles acting at this joint move the upper limb forward and backward, out to the side, and back across the body, as well as turning it inwards and outwards.

The rotator cuff is formed by four muscles that are attached to the scapula, and humerus. As well as producing movements at the shoulder, they also stabilize the shoulder joint, and prevent it from dislocating (popping out). The rotator cuff muscles are: supraspinatus, infraspinatus, teres minor, and subscapularis.

Tendonitis



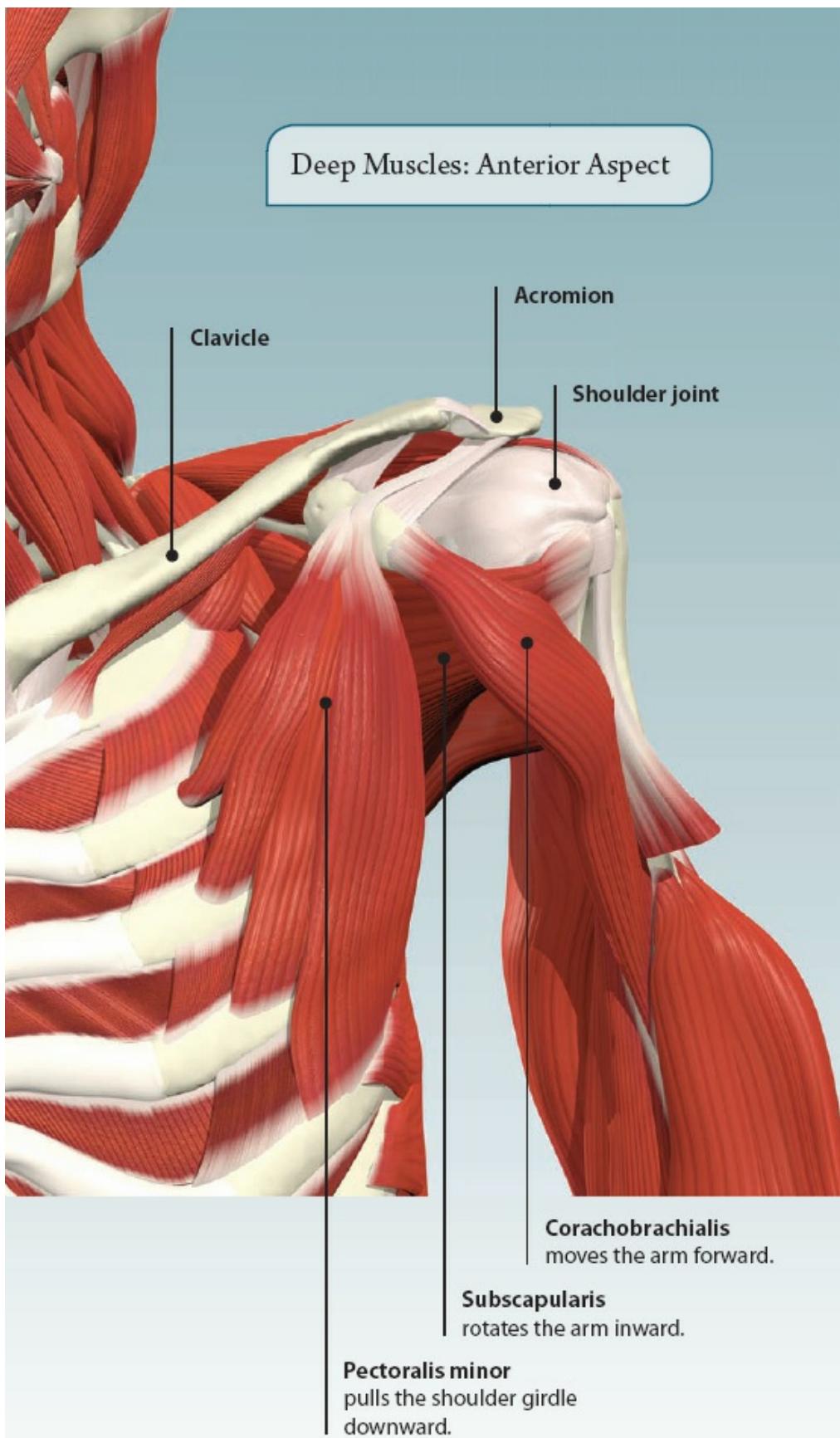
The tendon of the supraspinatus muscle passes beneath the acromion, through the narrow subacromial space. A fluid-lined sac, called the subacromial bursa, helps prevent friction from repetitive movements of the tendon. However, sometimes the bursa and tendon can get irritated and inflamed. This leads to pain when moving the arm out to the side, and is known as subacromial bursitis or supraspinatus tendonitis.



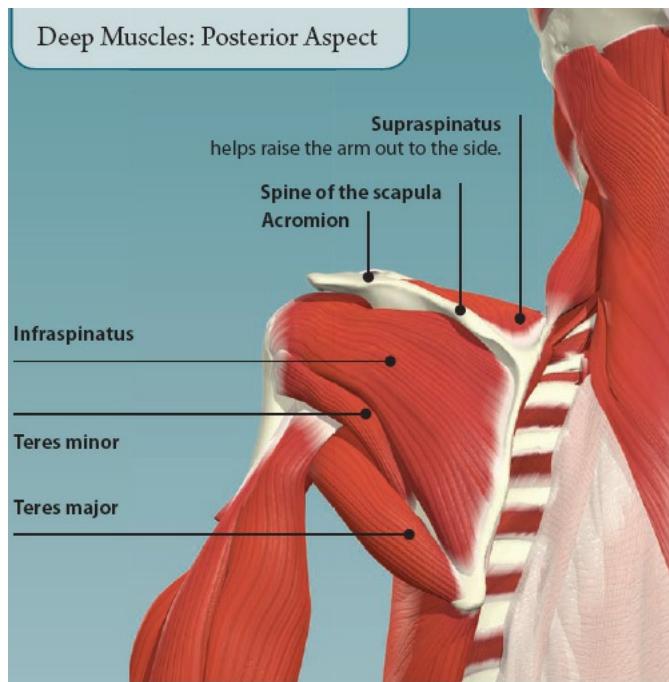
Did you know?

The deltoid muscle is a common site for giving intramuscular injections, due to its large size and easy accessibility.

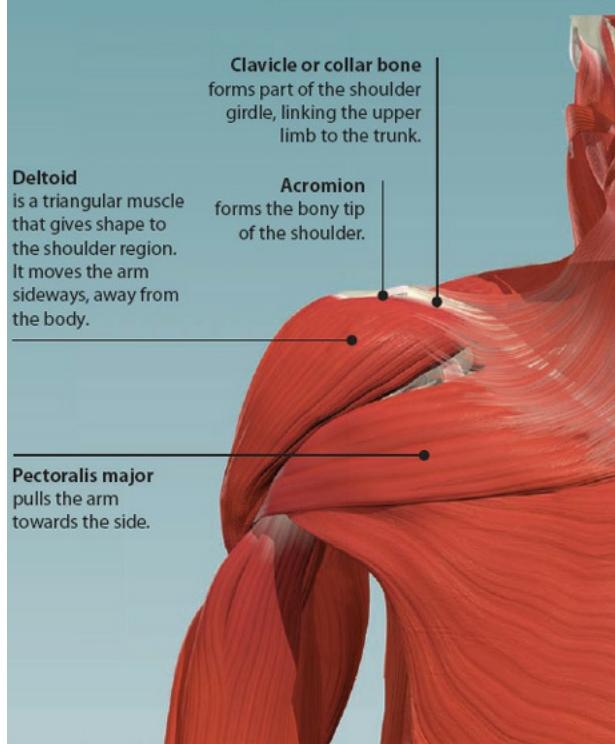
Deep Muscles: Anterior Aspect

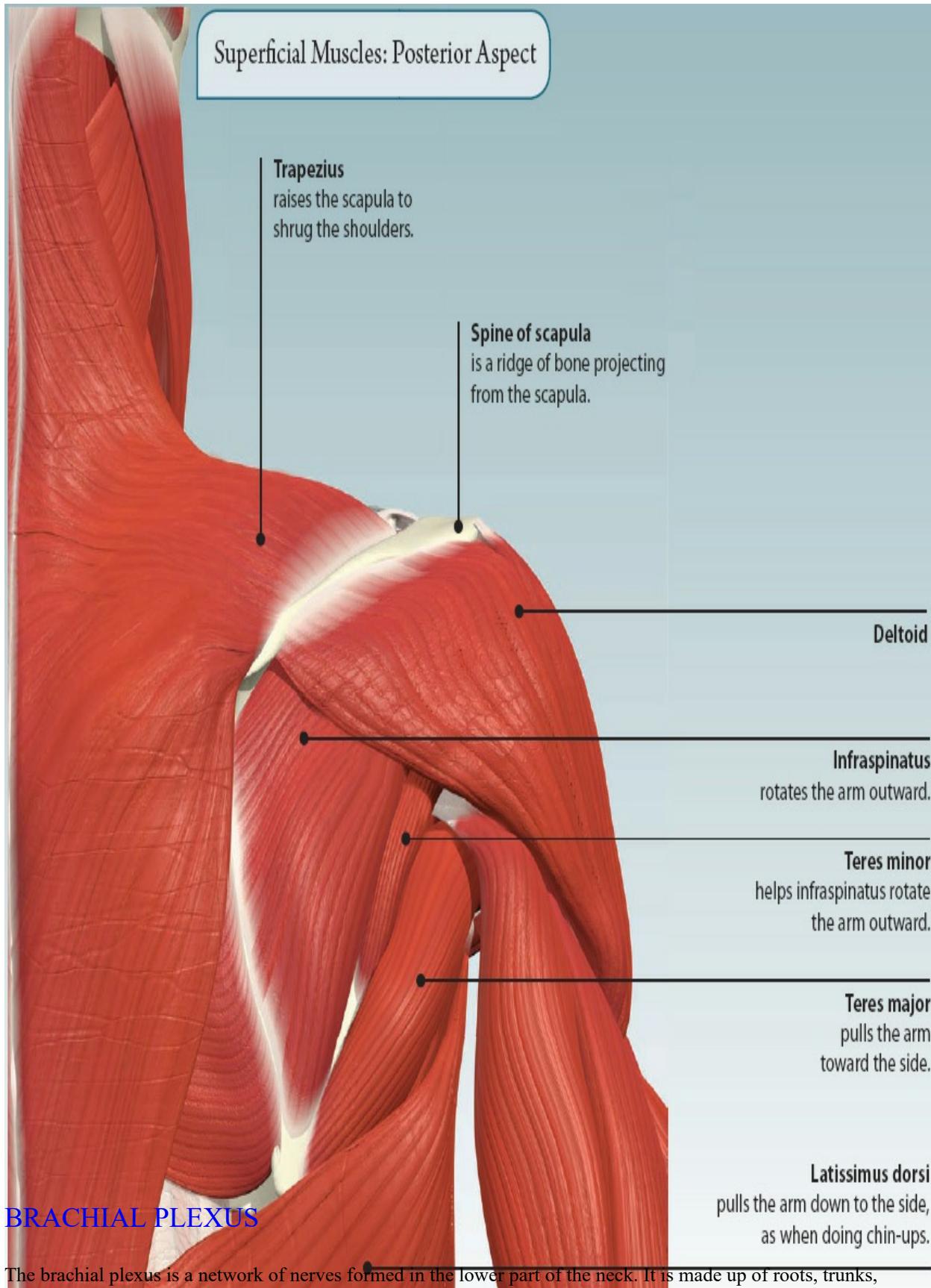


Deep Muscles: Posterior Aspect

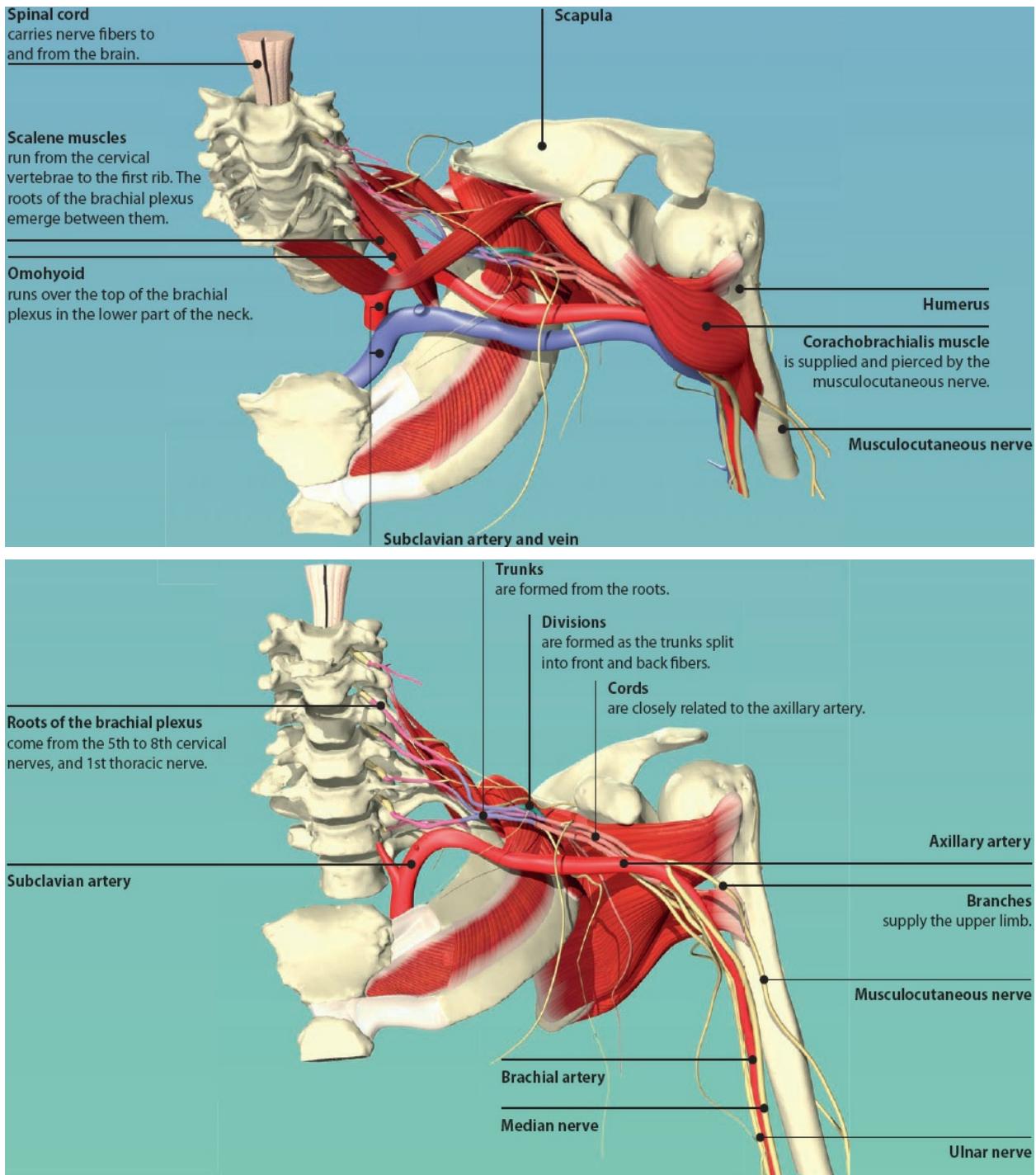


Superficial Muscles: Anterior Aspect





divisions, cords, and branches. The branches of the brachial plexus supply sensation and motor function to the entire upper limb. The five main branches of the brachial plexus are the axillary, median, musculocutaneous, radial, and ulnar nerves.



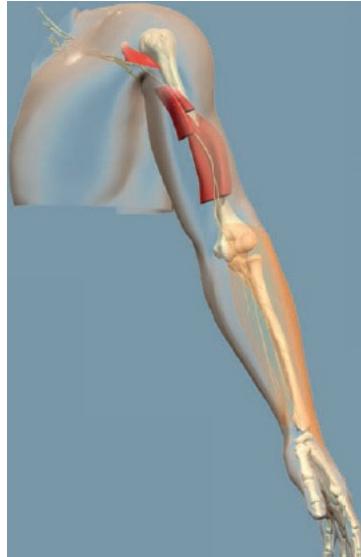
Nerves of the Brachial Plexus

**Median nerve**

innervates muscles of the forearm that bend the fingers and wrist. It also supplies sensation to the thumb, index, and middle finger.

**Ulnar nerve**

innervates the small muscles of the hand along with a few muscles of the forearm. It supplies sensation to the skin over the ring and little finger.

**Musculocutaneous nerve**

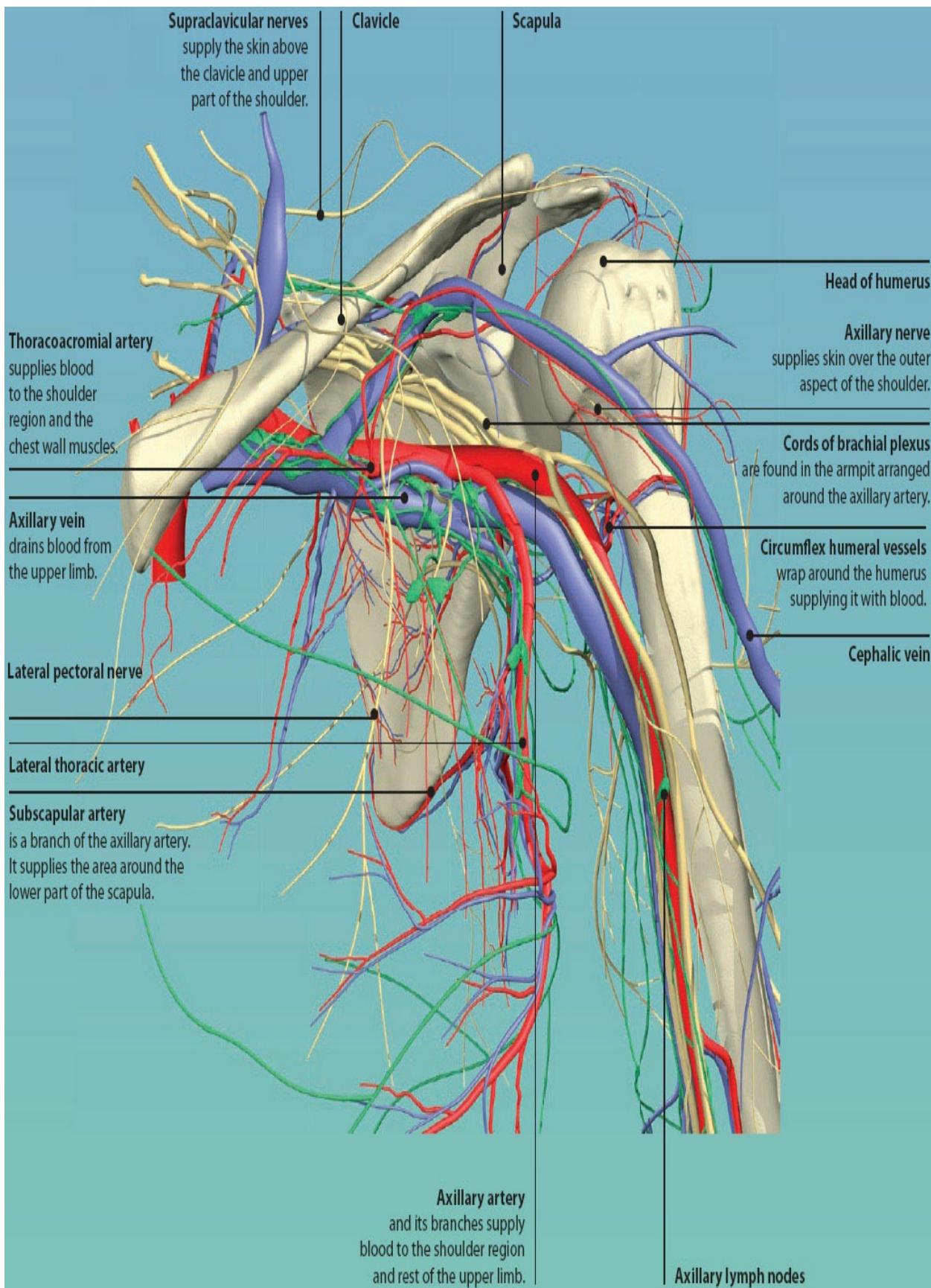
innervates muscles of the arm that bend the elbow. It also supplies sensation to part of the forearm.

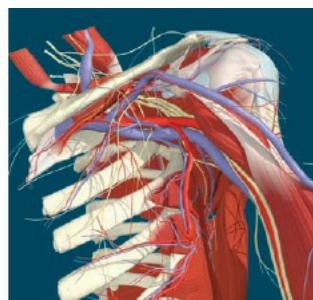
**Radial nerve**

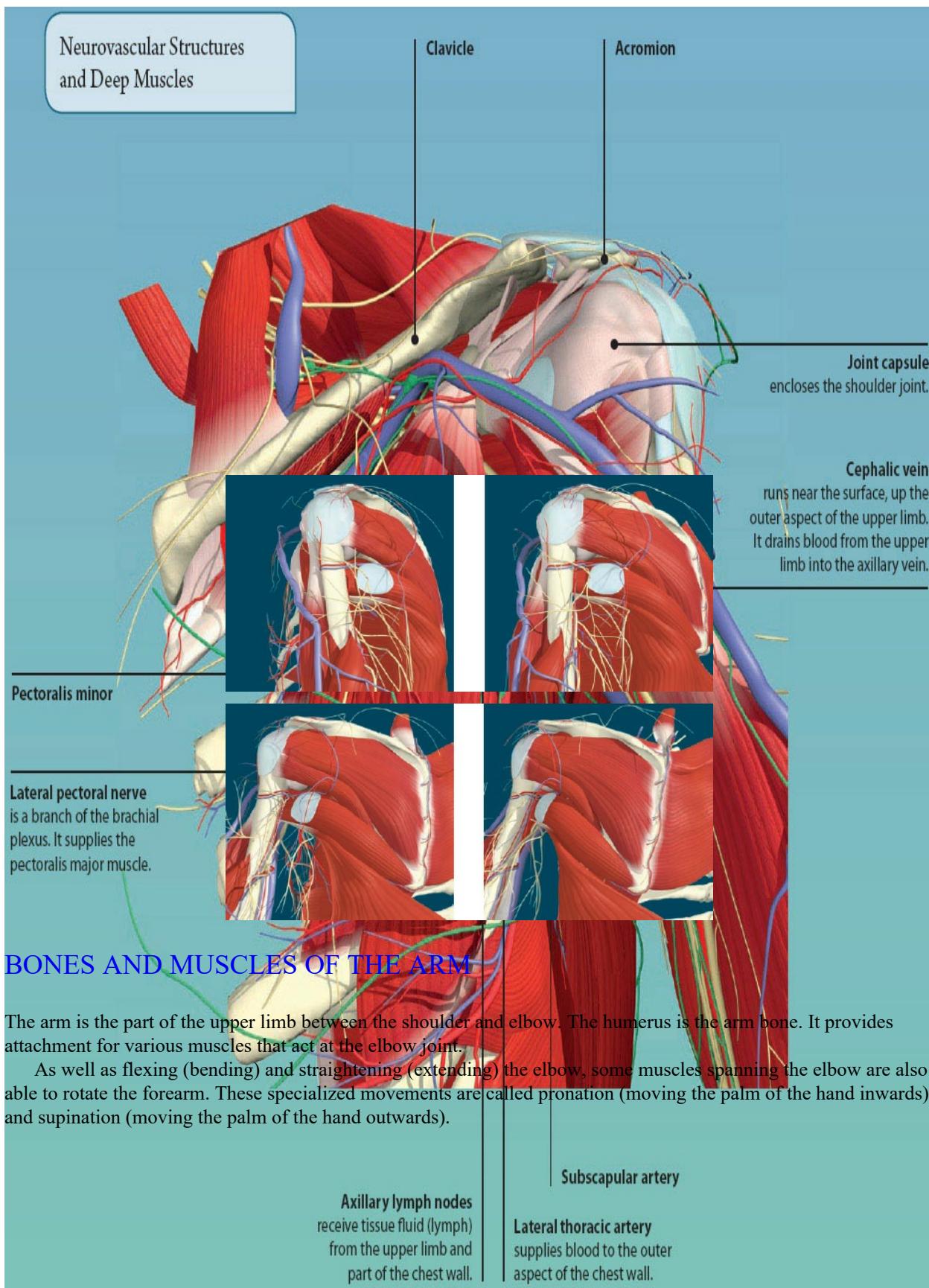
innervates muscles of the arm and forearm that straighten the fingers, wrist, and elbow. It also supplies sensation to the back of the arm, forearm, and part of the hand.

NEUROVASCULAR STRUCTURES OF THE SHOULDER

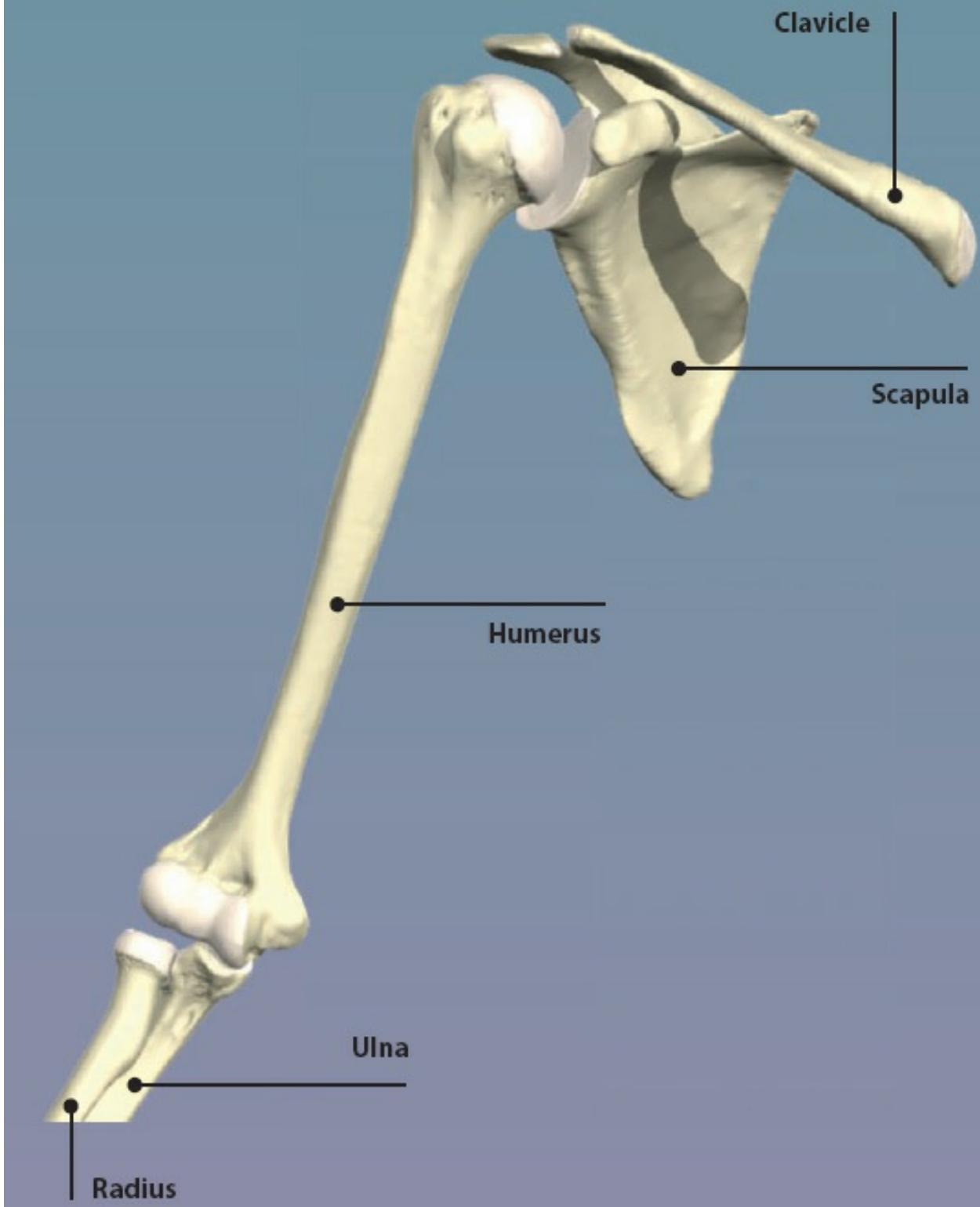
The shoulder region is packed with blood vessels and nerves, which pass through the axilla (armpit) to reach the rest of the upper limb.



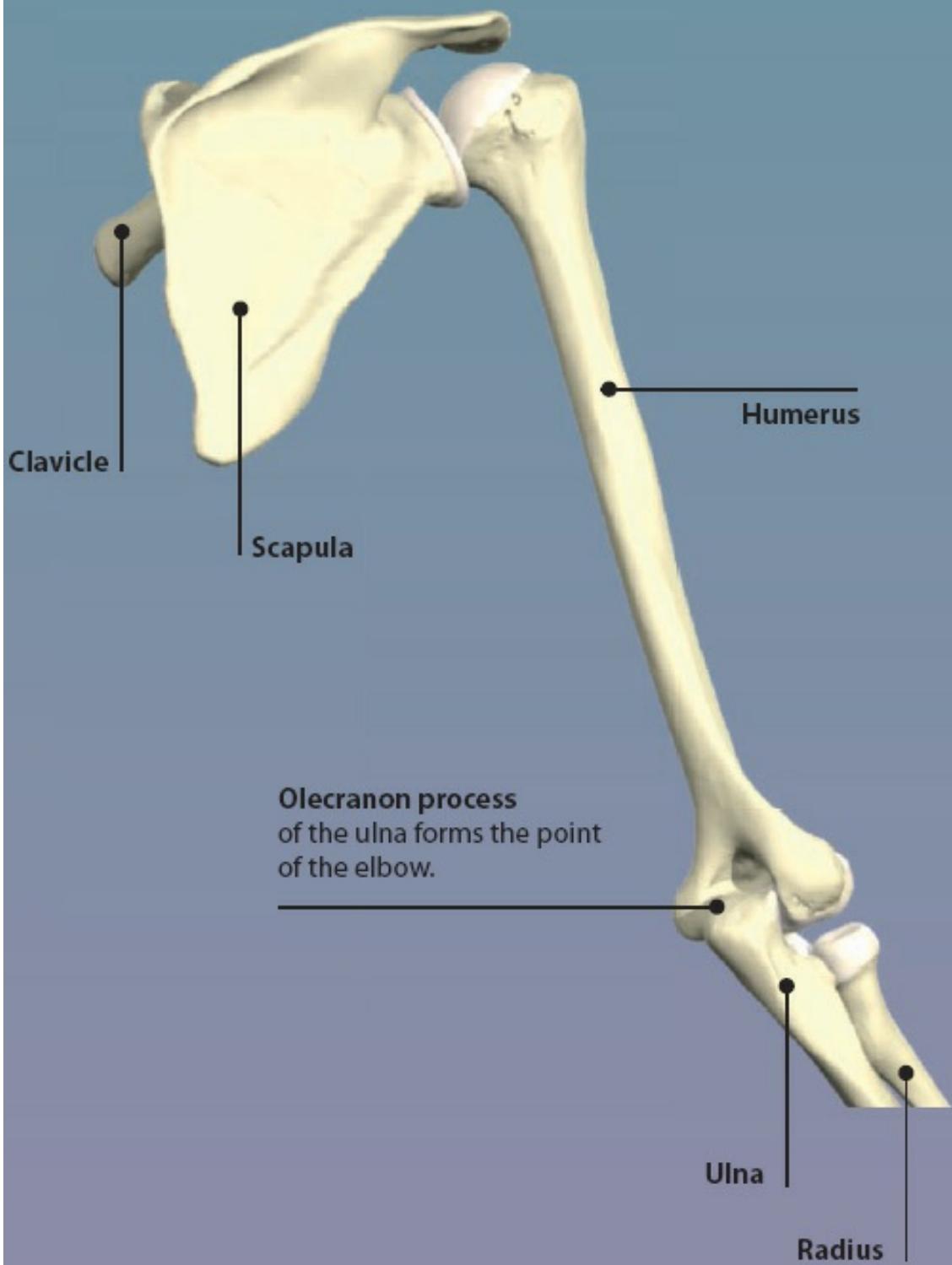


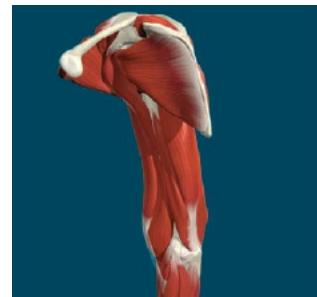
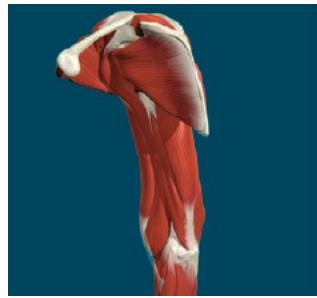


Bones of the Arm: Anterior Aspect

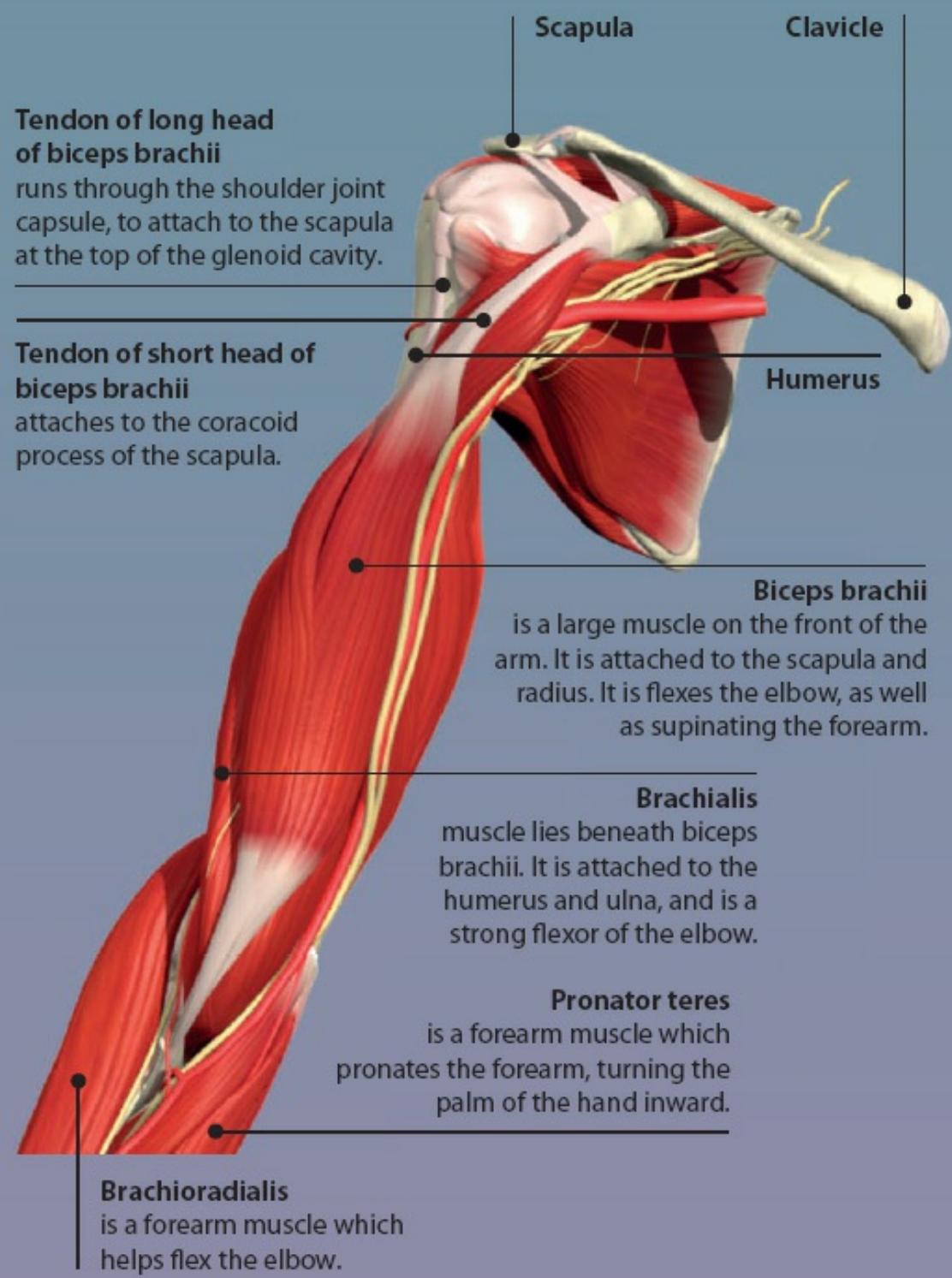


Bones of the Arm: Posterior Aspect

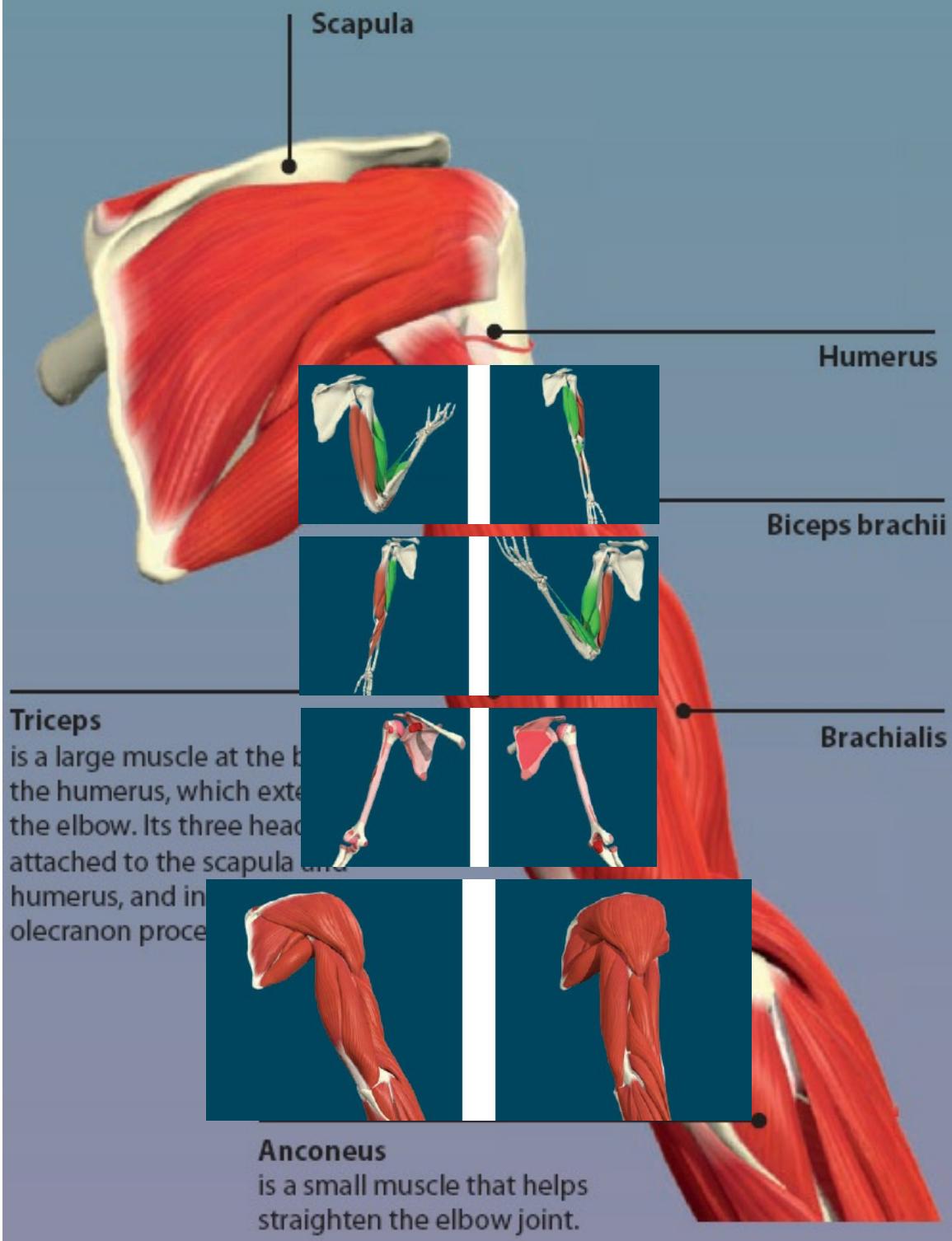


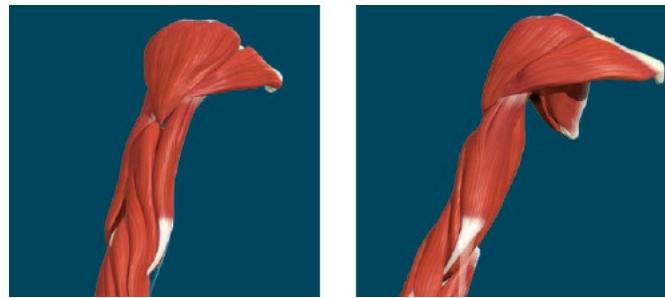


Deep Muscles of the Arm: Anterior Aspect



Deep Muscles of the Arm: Posterior Aspect

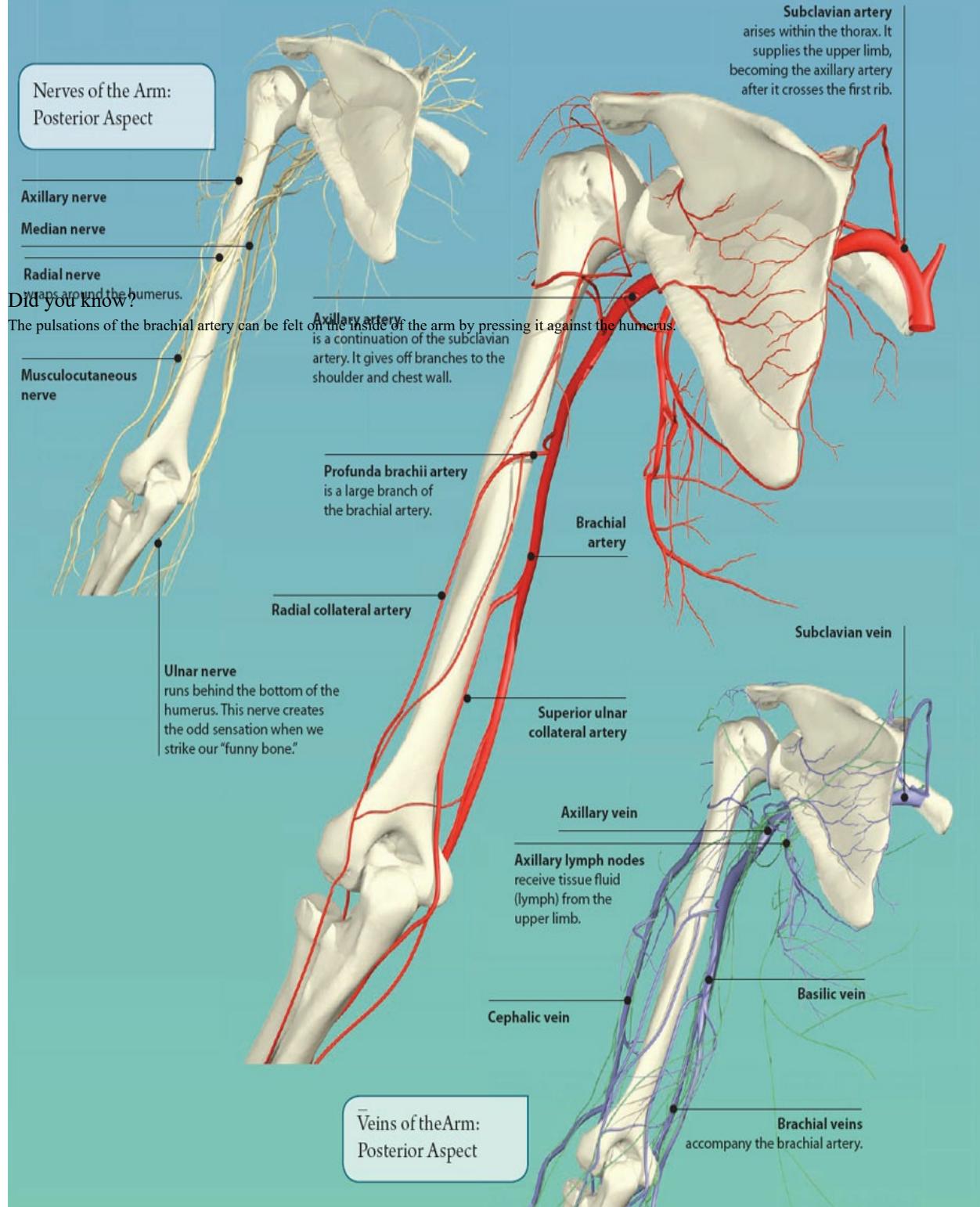




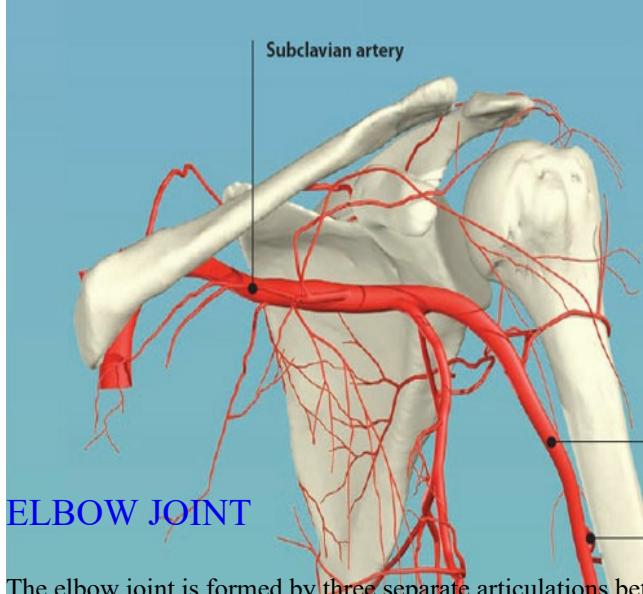
NEUROVASCULAR STRUCTURES OF THE ARM

The brachial artery and its branches supply blood to the arm. The cephalic and basilic veins run through the arm, draining blood from the upper limb. Branches from the brachial plexus supply muscles and skin within the upper limb.

Arteries of the Arm: Posterior Aspect



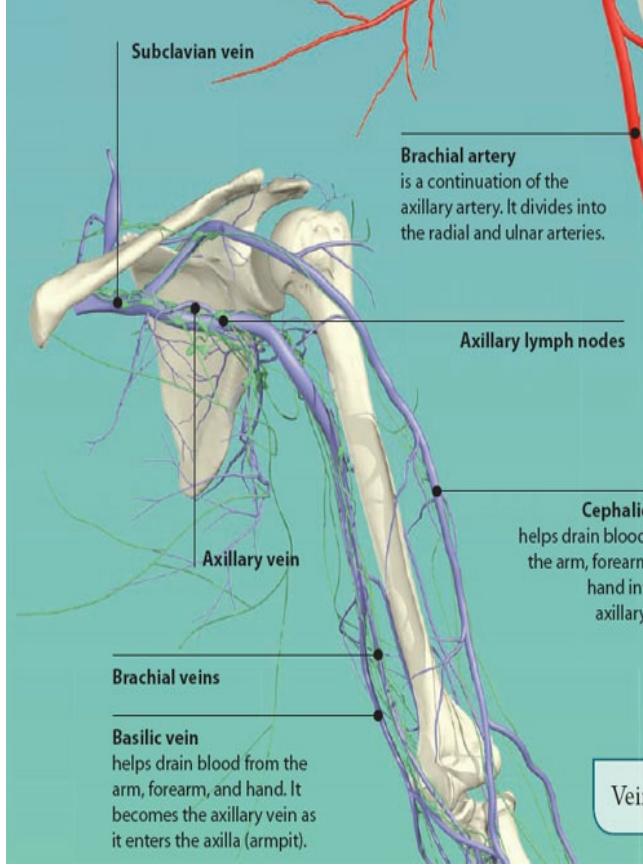
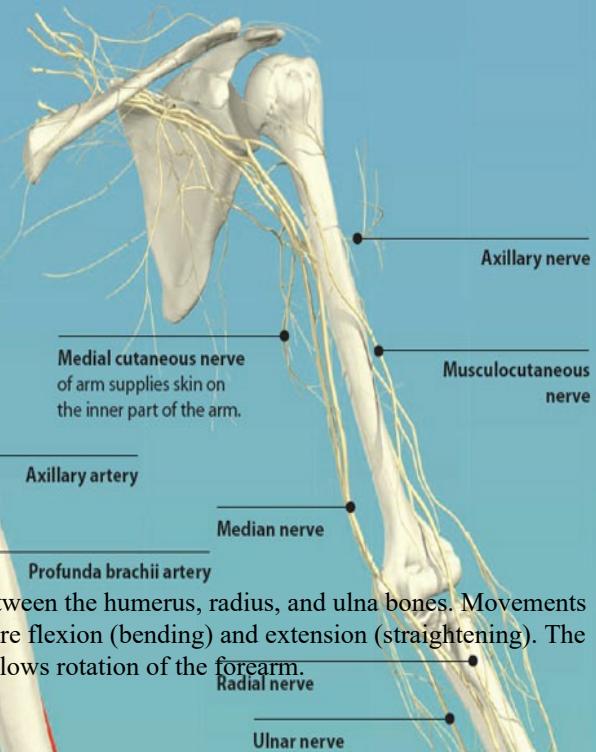
Arteries of the Arm: Anterior Aspect



ELBOW JOINT

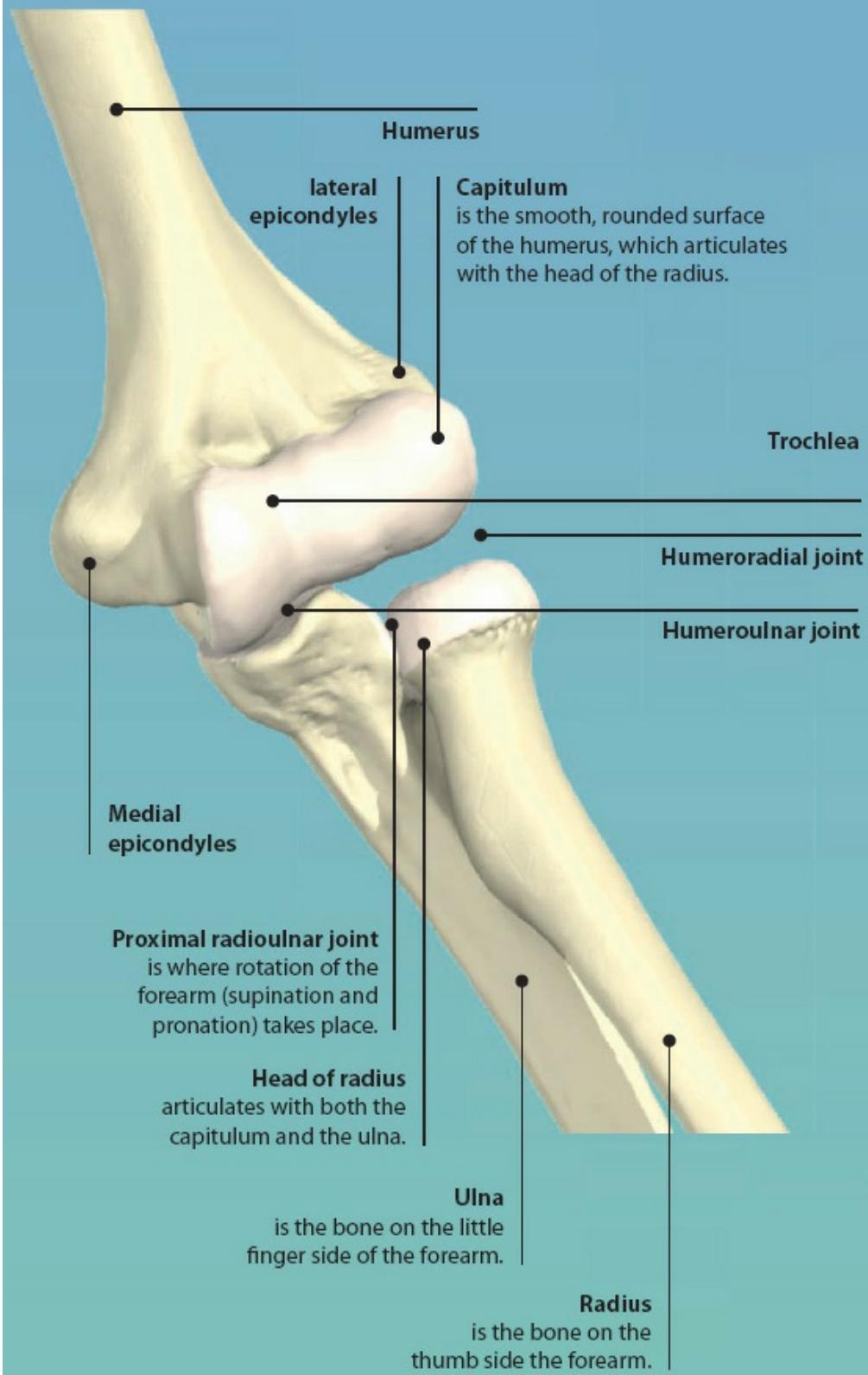
The elbow joint is formed by three separate articulations between the humerus, radius, and ulna bones. Movements that take place at the humeroradial and humeroulnar joints are flexion (bending) and extension (straightening). The radius and ulna form the proximal radioulnar joint, which allows rotation of the forearm.

Nerves of the Arm: Anterior Aspect

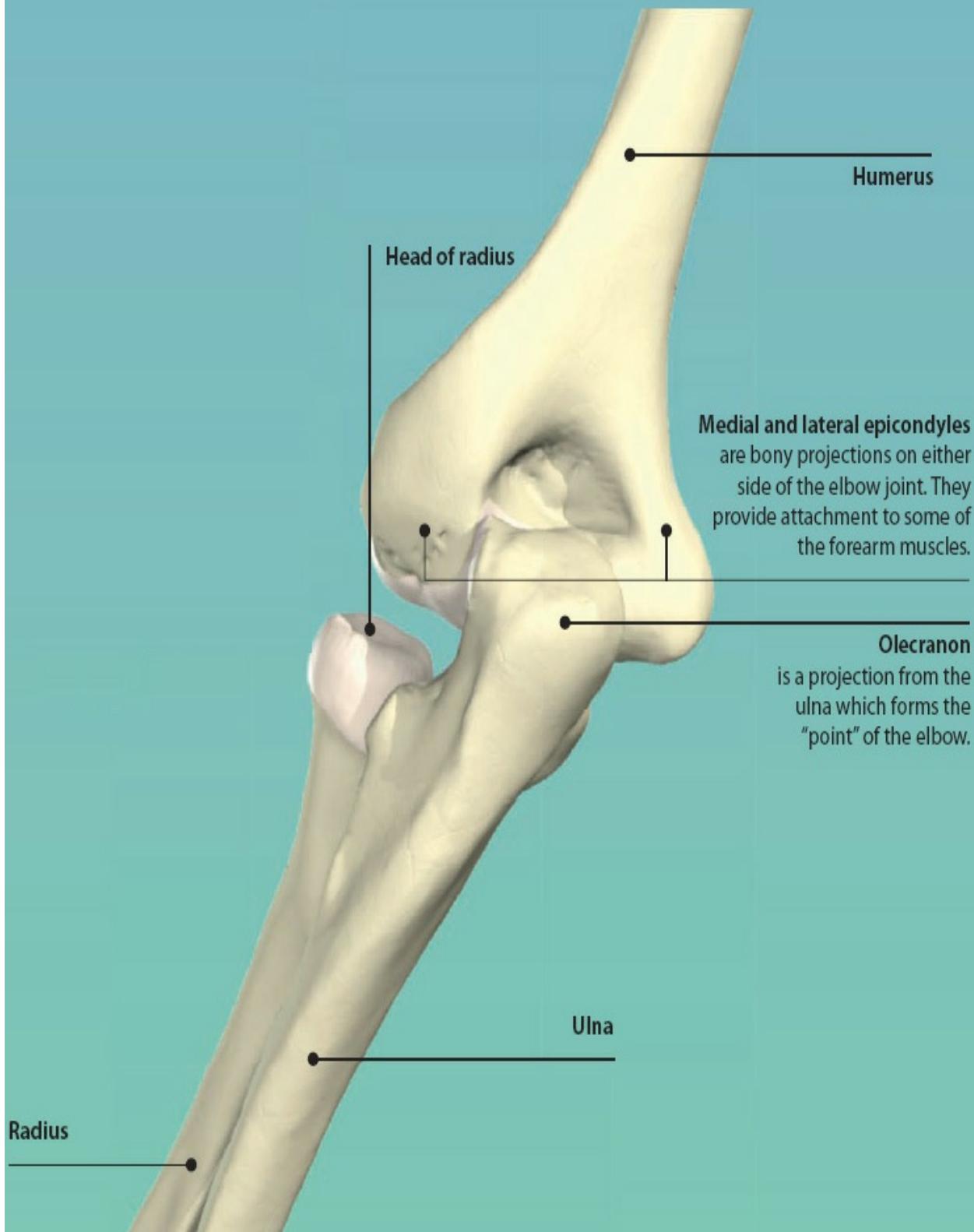


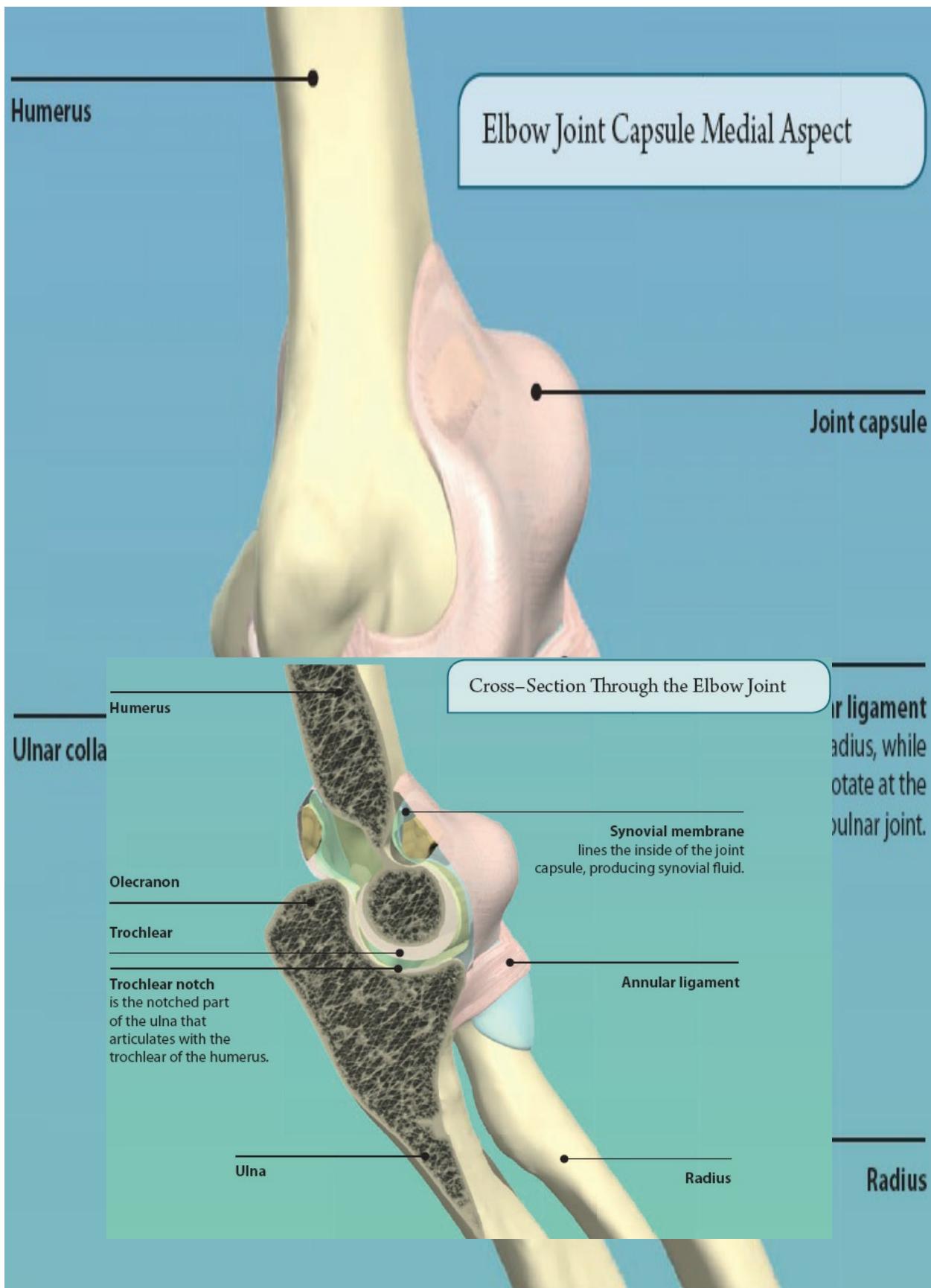
Veins of the Arm: Anterior Aspect

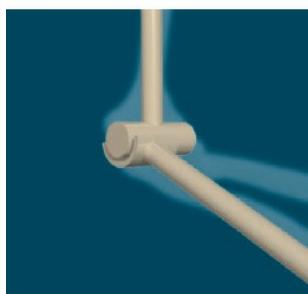
Bones of the Elbow: Anterior Aspect

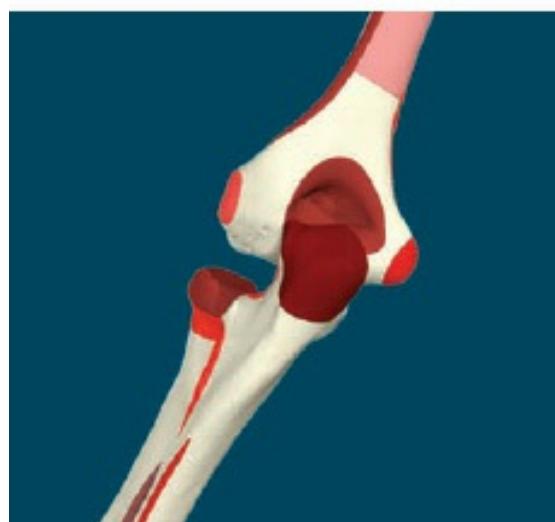
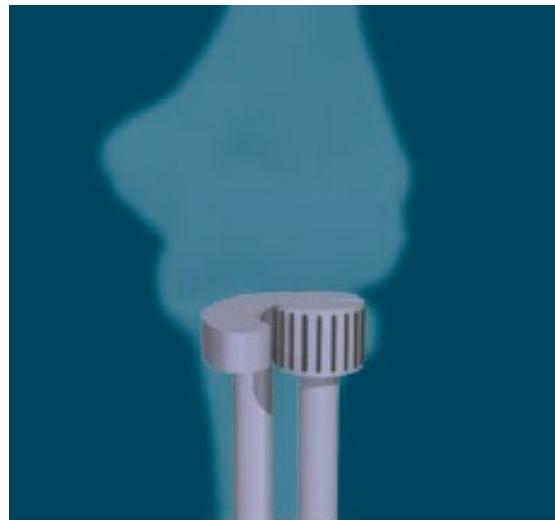


Bones of the Elbow: Posterior Aspect





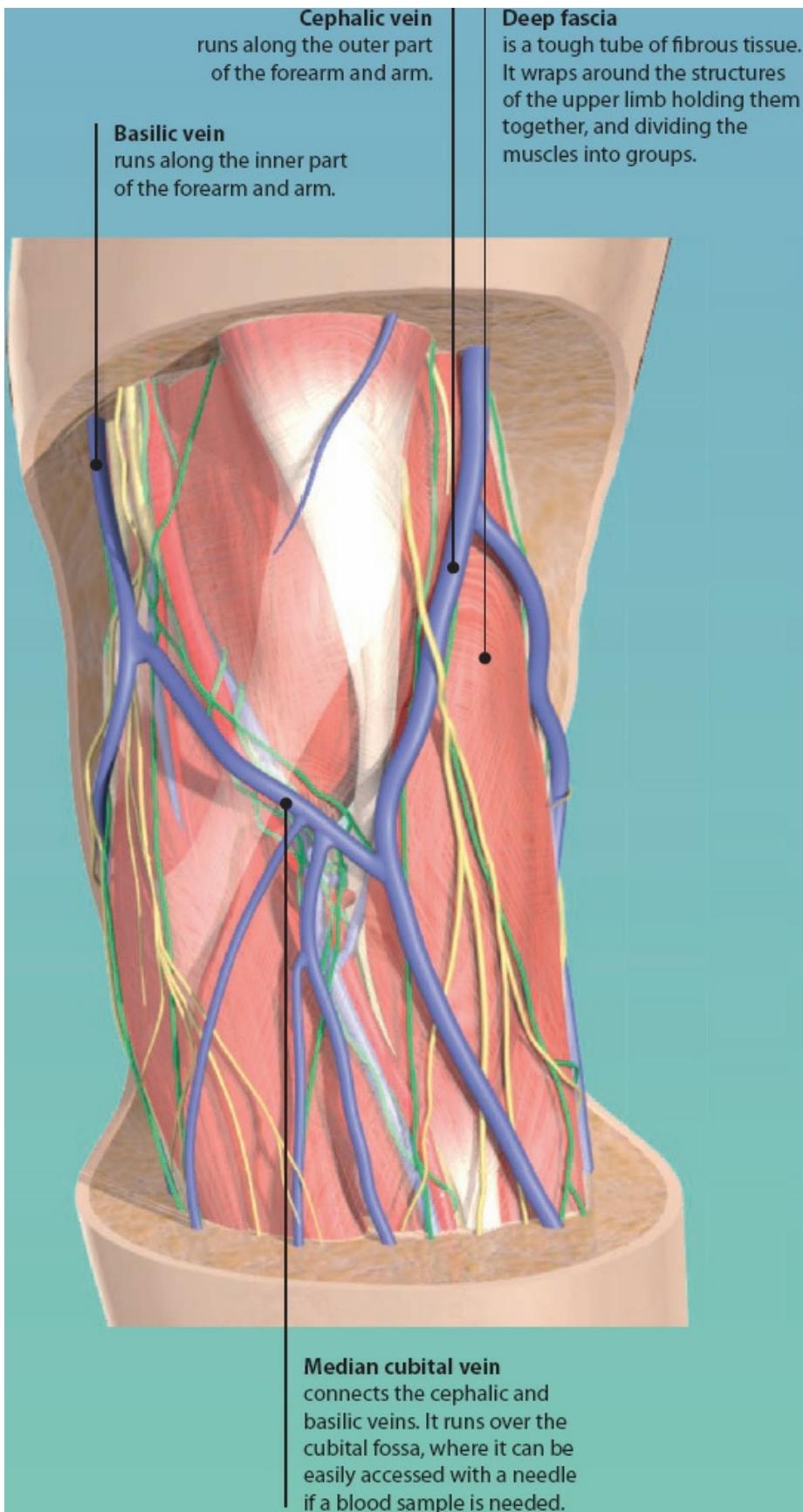


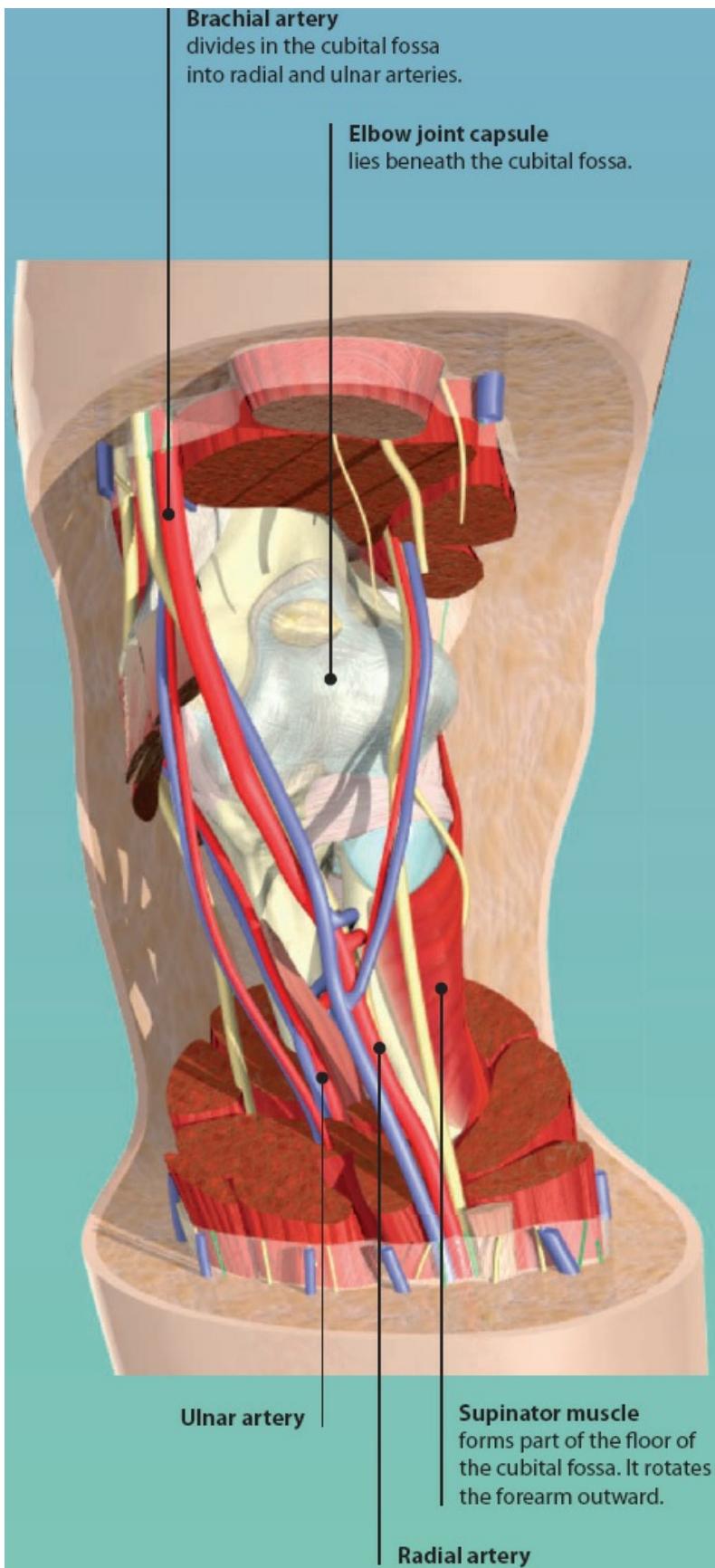


CUBITAL FOSSA DISSECTION

The cubital fossa is a triangular-shaped region in front of the elbow joint. The apex is formed by the brachioradialis muscle on the outside, and pronator teres muscle on the inside. The base of the triangle runs between the two bony prominences on either side of the elbow (medial and lateral epicondyles).

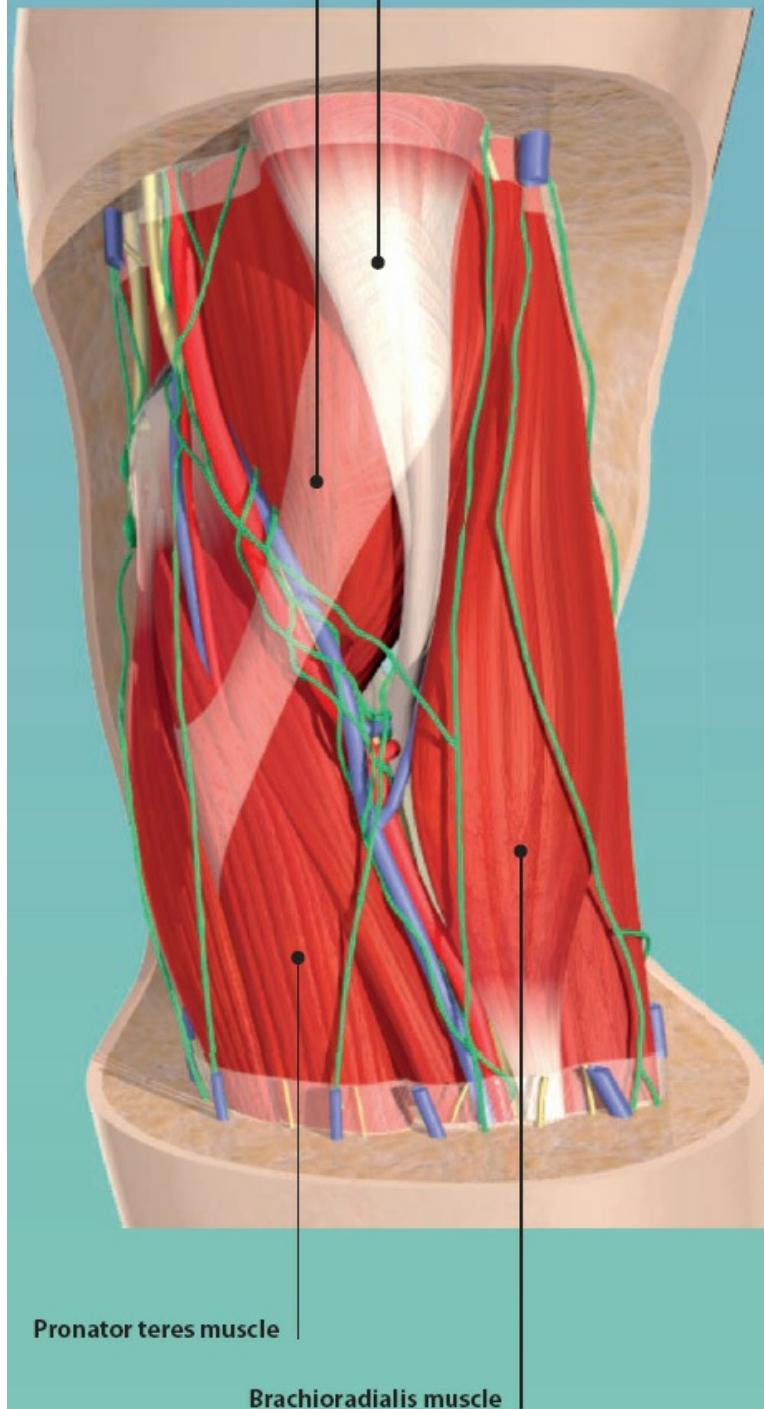
Many important structures pass over or through the cubital fossa as they travel between the arm and forearm.





Bicipital aponeurosis
is a tough fibrous band which can
be felt running over the cubital
fossa. It attaches the tendon of
the biceps brachii to the deep
fascia.

Tendon of biceps brachii
runs through the cubital fossa
to attach to the radius.

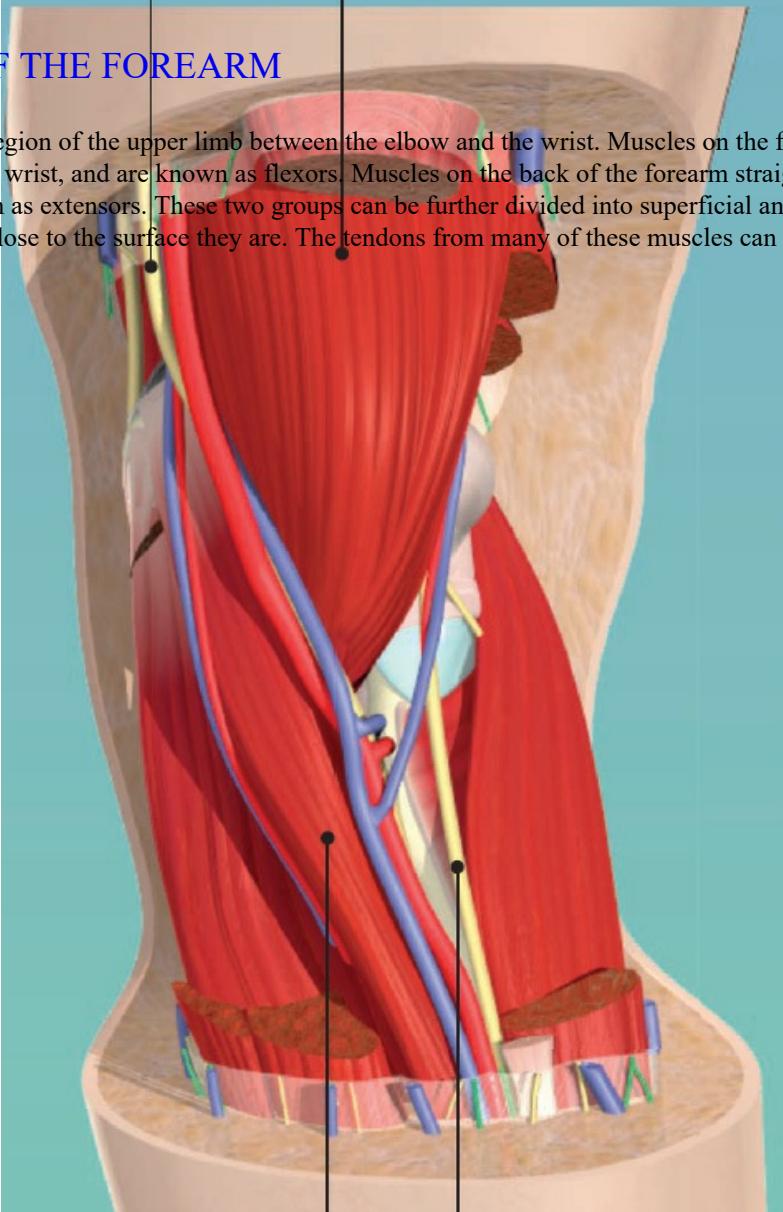


Median nerve
passes through the cubital fossa,
to supply muscles that bend the
fingers and thumb.

Brachialis muscle
forms the floor of the cubital
fossa.

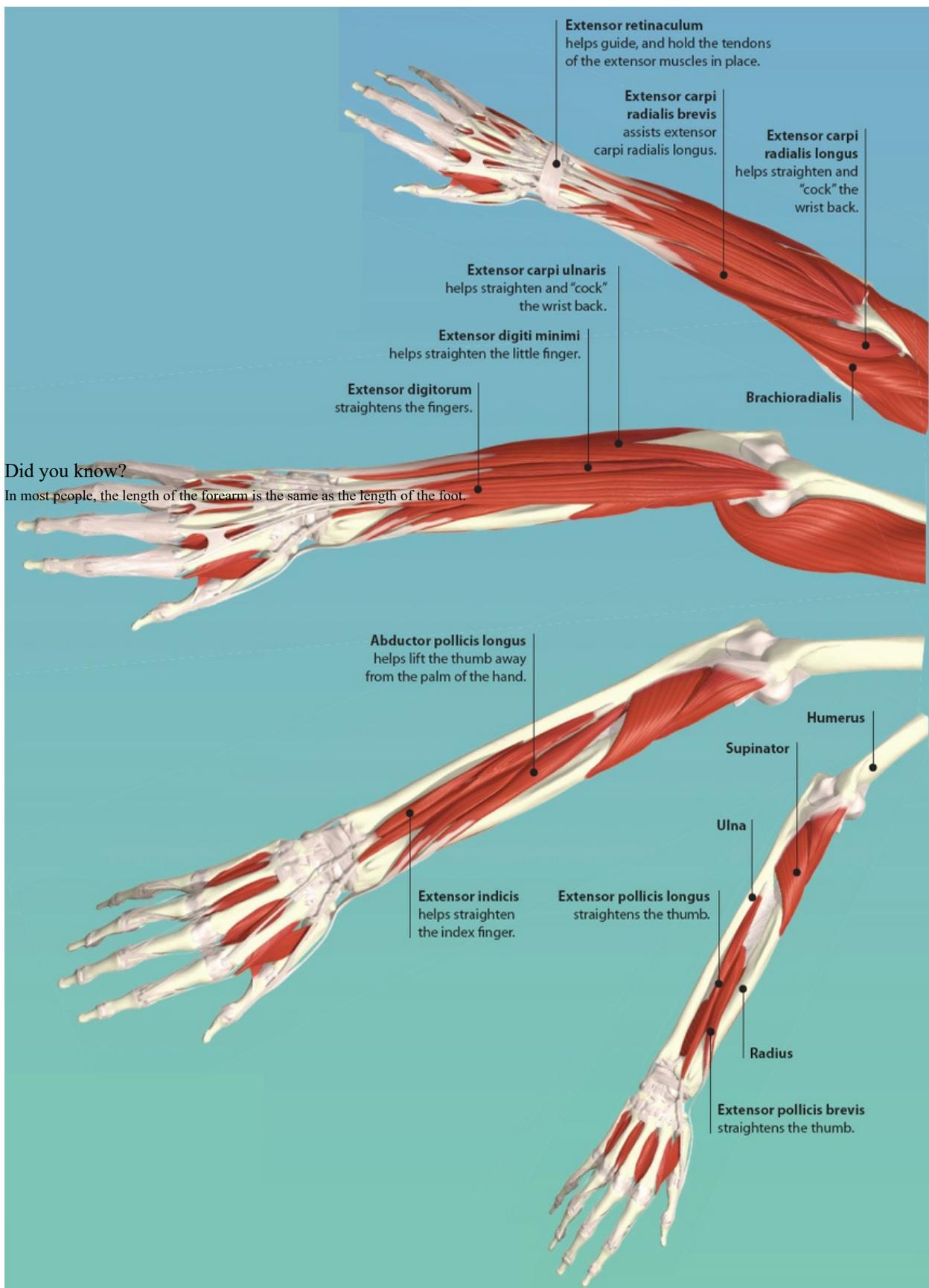
MUSCLES OF THE FOREARM

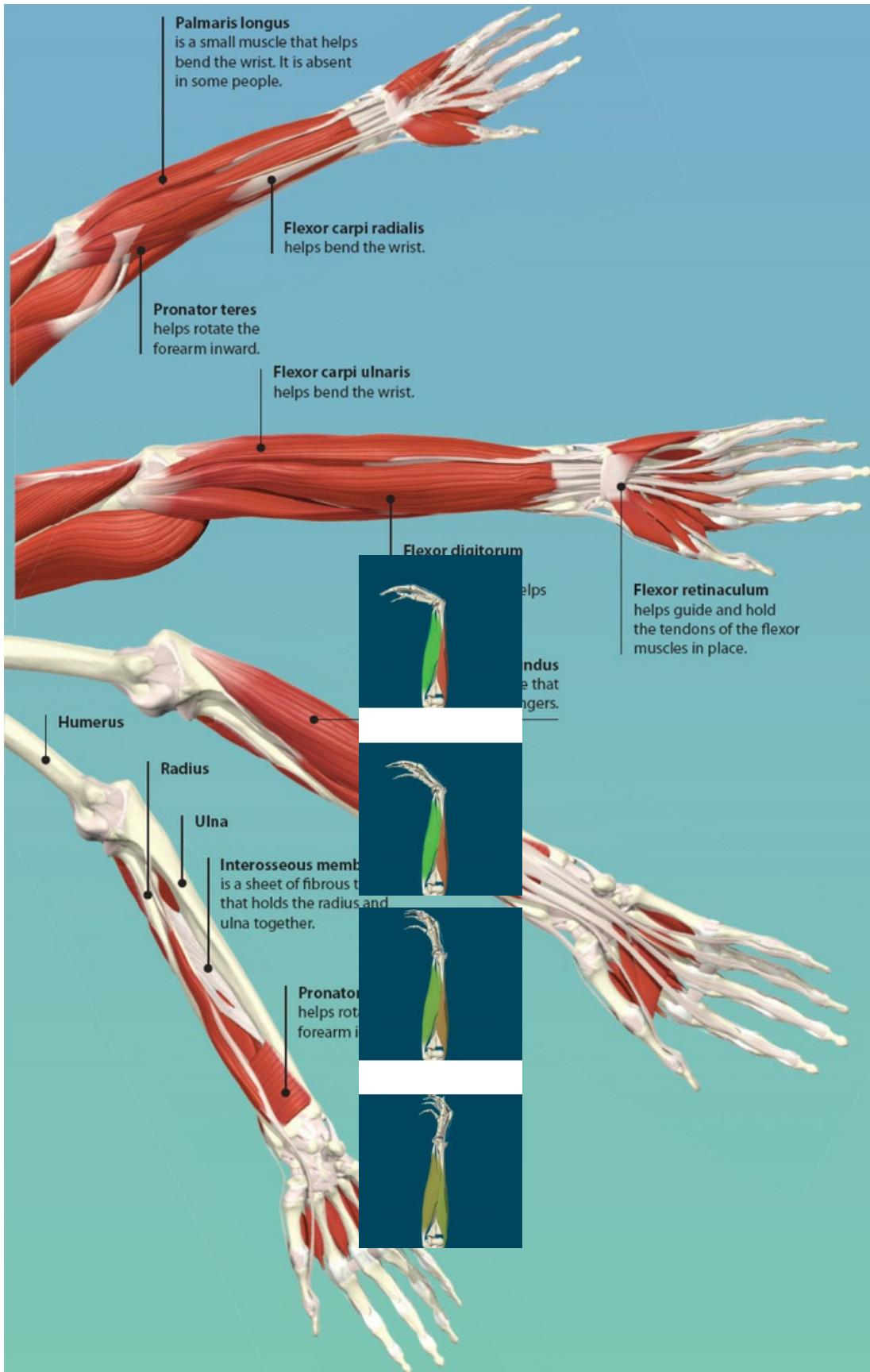
The forearm is the region of the upper limb between the elbow and the wrist. Muscles on the front of the forearm bend the fingers and wrist, and are known as flexors. Muscles on the back of the forearm straighten the fingers and wrist, and are known as extensors. These two groups can be further divided into superficial and deep muscles, depending on how close to the surface they are. The tendons from many of these muscles can be easily seen around the wrist.



Pronator teres muscle

Superficial radial nerve
lies behind brachioradialis and
supplies sensation around the
base of the thumb.

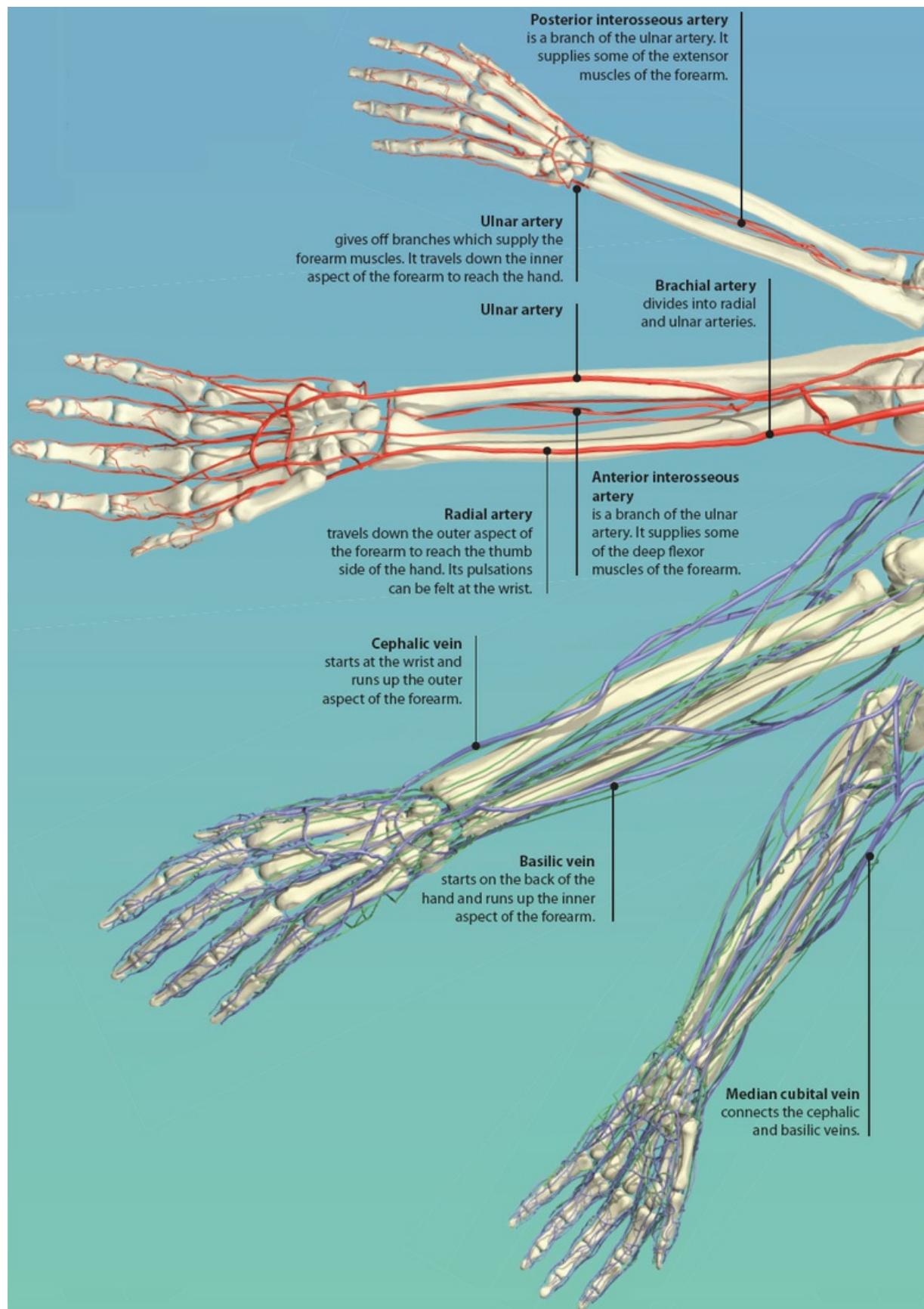


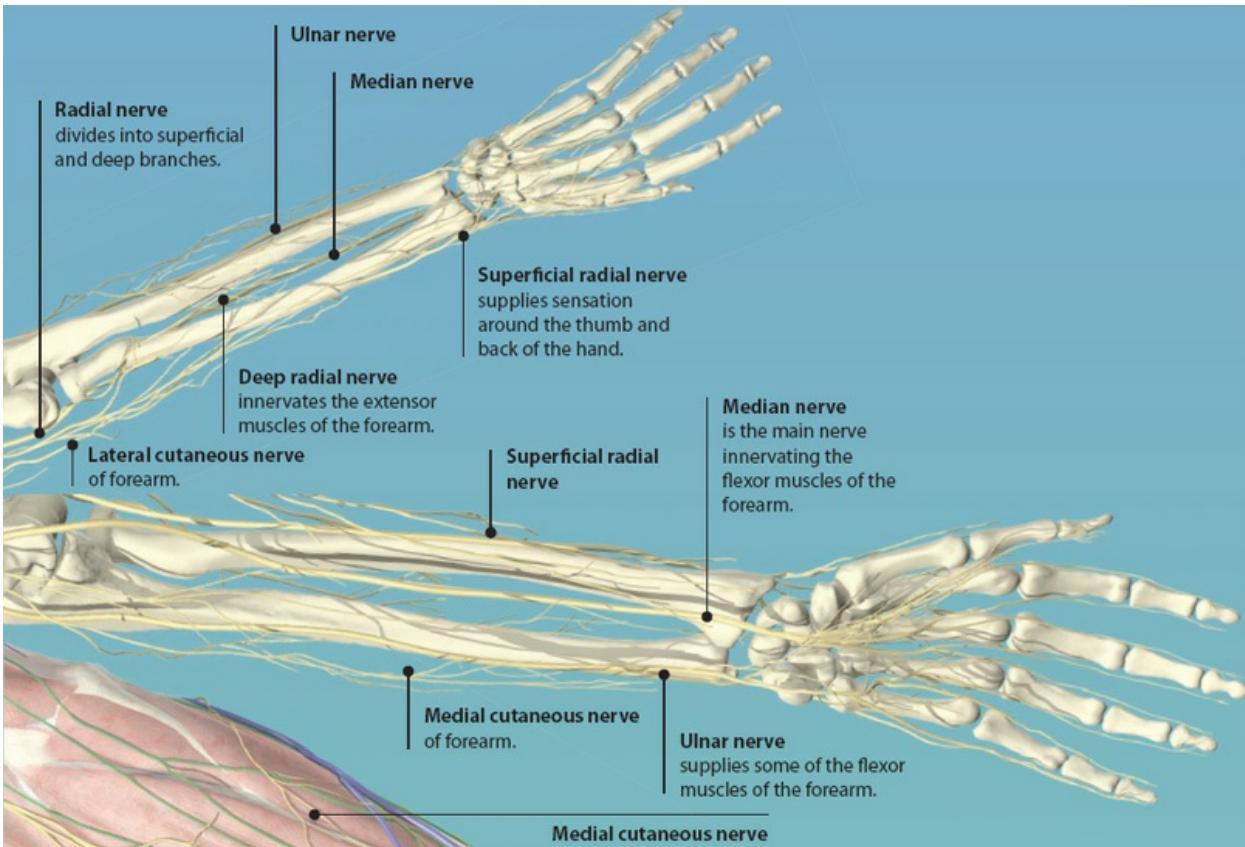




VESSELS OF THE FOREARM

The muscles and skin of the forearm are supplied by various nerves, and blood vessels. Many of these continue through to supply structures in the hand.



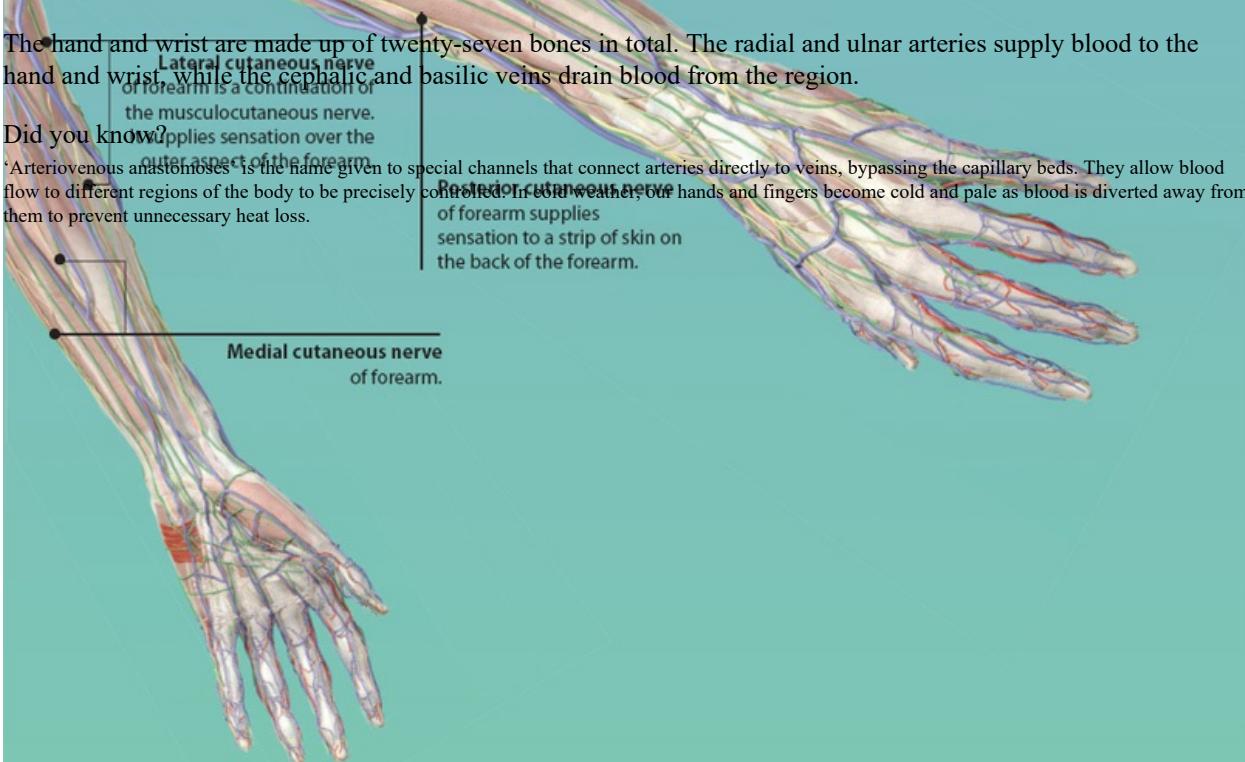


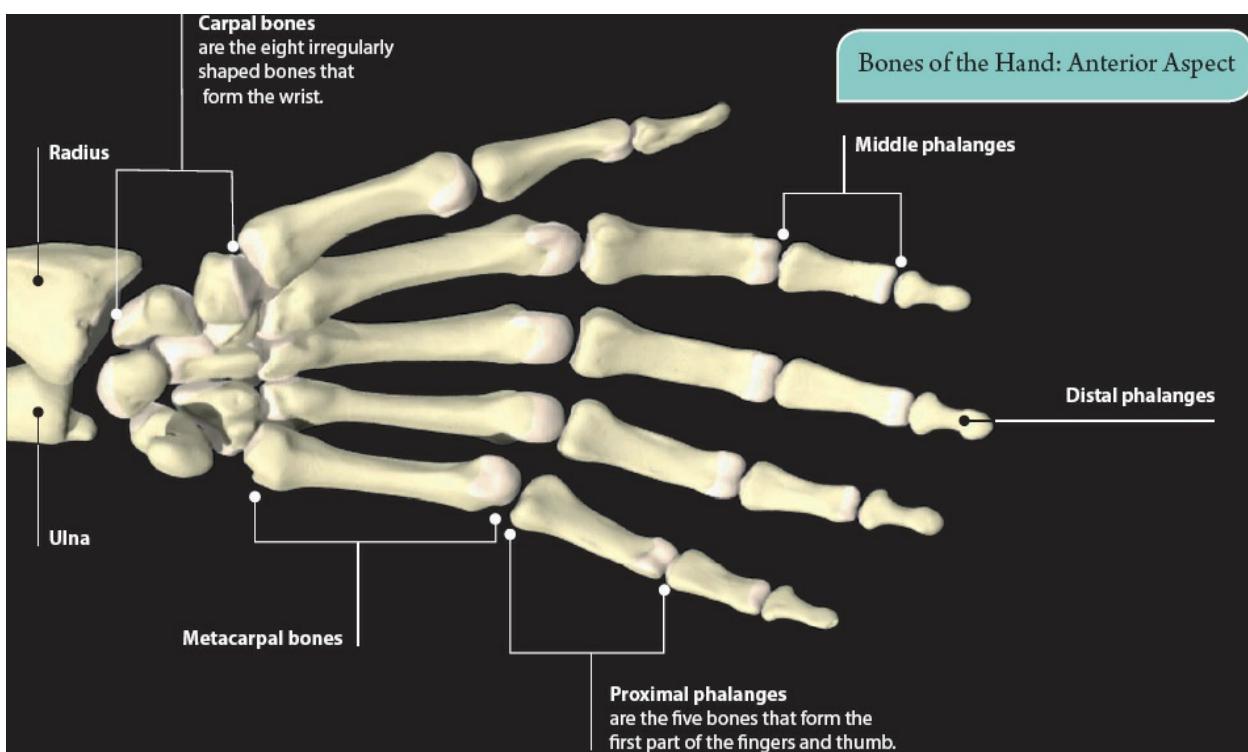
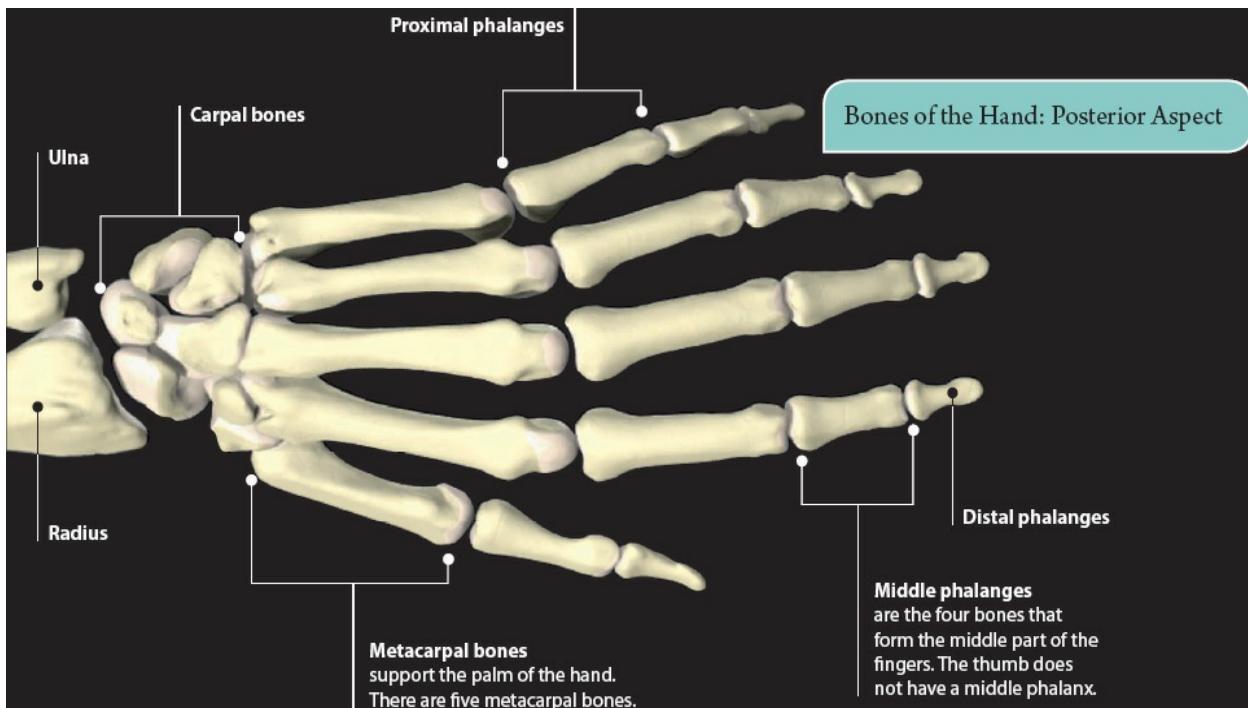
BONES AND VESSELS OF THE HAND

The hand and wrist are made up of twenty-seven bones in total. The radial and ulnar arteries supply blood to the hand and wrist, while the cephalic and basilic veins drain blood from the region.

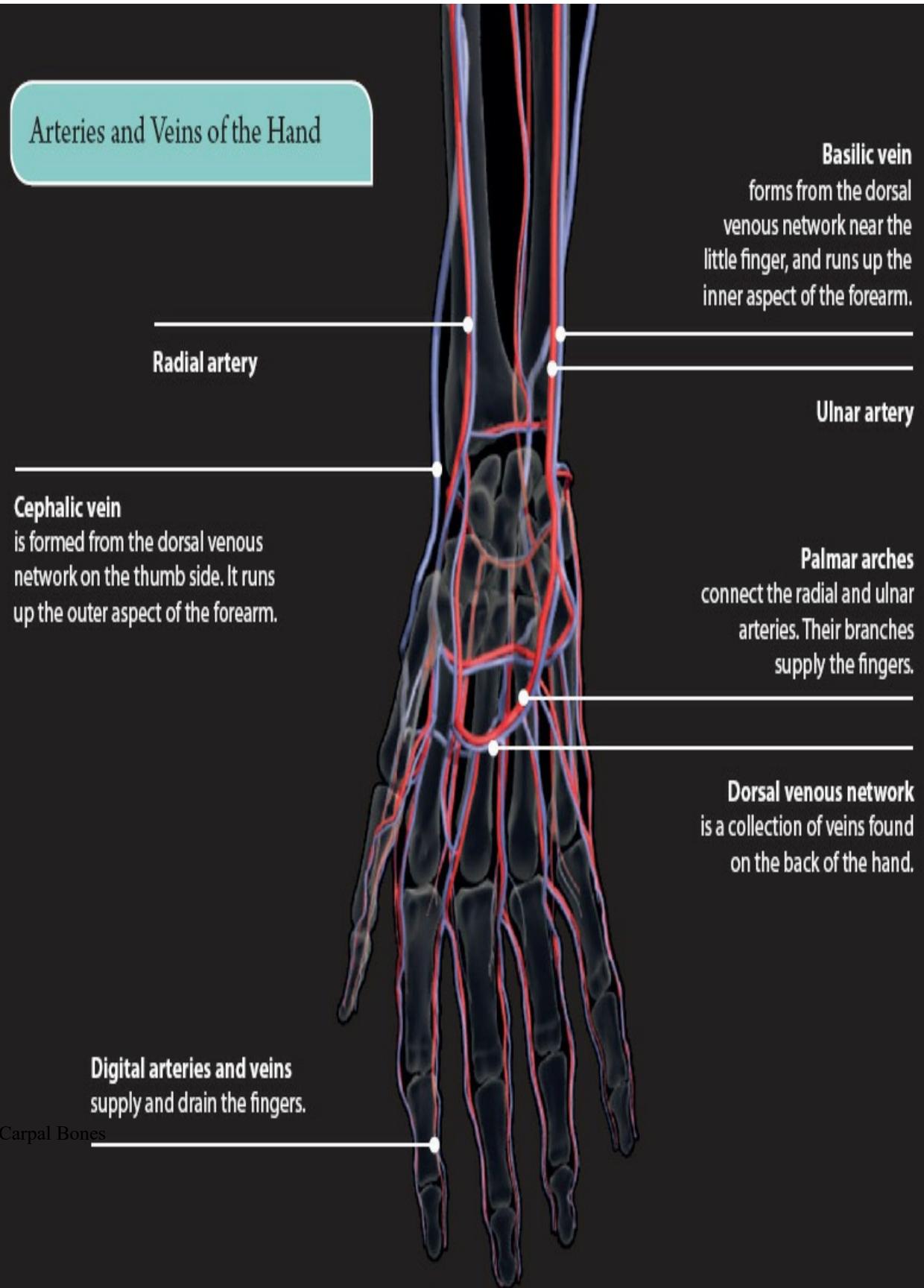
Did you know? *Lateral cutaneous nerve of forearm* is a continuation of the musculocutaneous nerve.

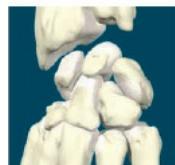
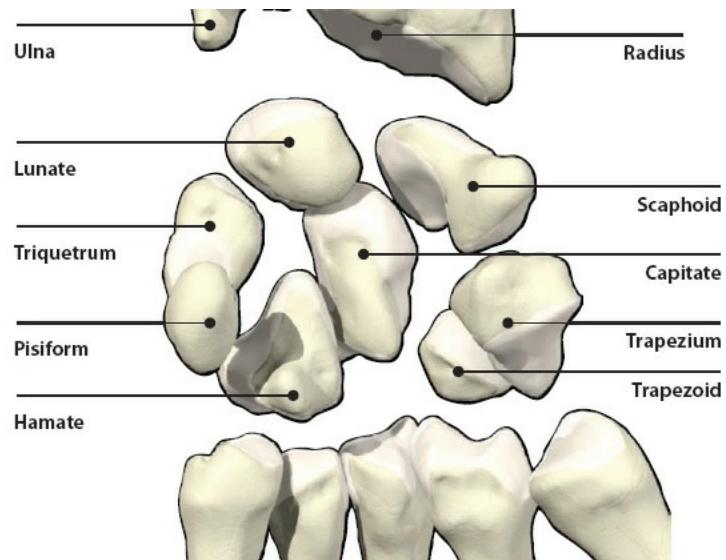
'Arteriovenous anastomoses' is the name given to special channels that connect arteries directly to veins, bypassing the capillary beds. They allow blood flow to different regions of the body to be precisely controlled. In cold weather, our hands and fingers become cold and pale as blood is diverted away from them to prevent unnecessary heat loss.





Arteries and Veins of the Hand







MUSCLES OF THE HAND

The hand contains a number of small muscles. They assist the muscles of the forearm in bending and straightening the fingers and thumb. They also allow the fingers to be spread apart (abduction) and brought back together (adduction).

Extensor Muscles

Interossei

are small muscles found between the metacarpals of the fingers and thumb.

They spread the fingers (abduction) and move them back together (adduction).

Metacarpals

Tendons of extensor digitorum attach to the extensor hoods and straighten the fingers.

Did you know?

If you move your thumb out to the side, a triangular hollow can be seen to appear at the base of the thumb, formed from the extensor tendons of the thumb. It is called the "anatomical snuffbox" as it was used to hold snuff (powdered tobacco) prior to being inhaled through the nose.



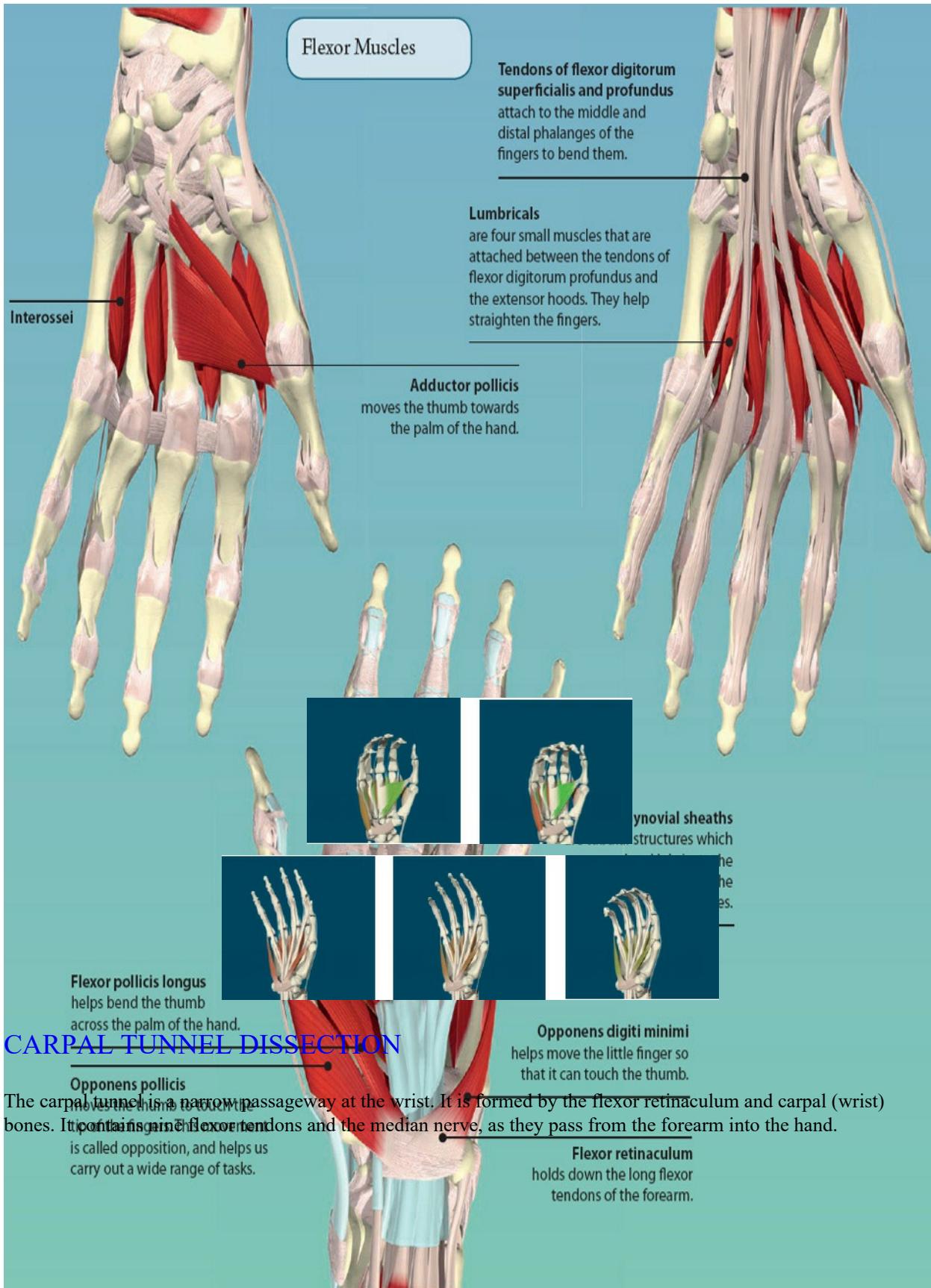
Extensor hoods

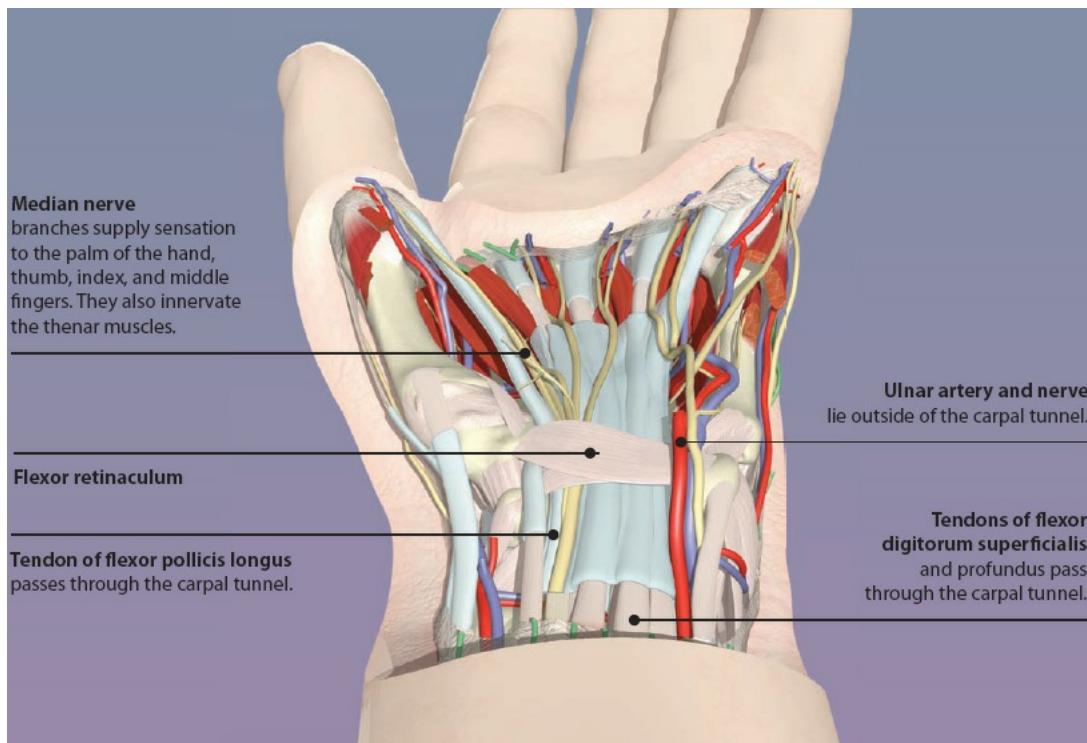
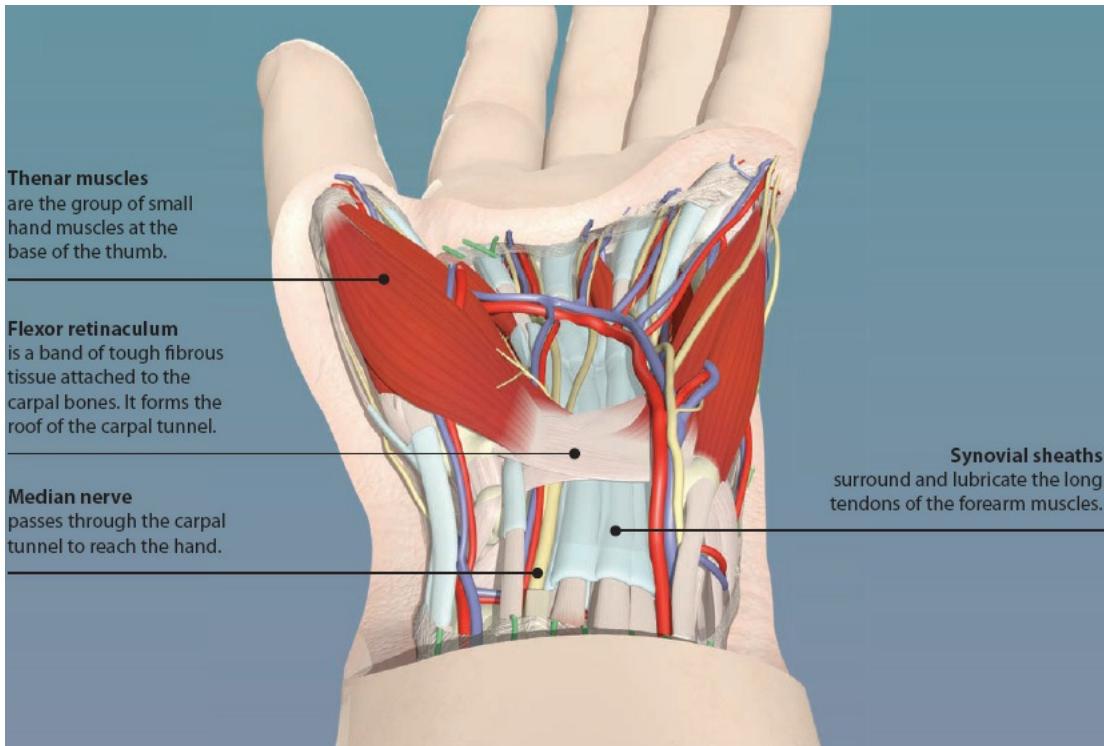
are complex fibrous structures covering the back of the fingers. Muscles attached to them help straighten the fingers.

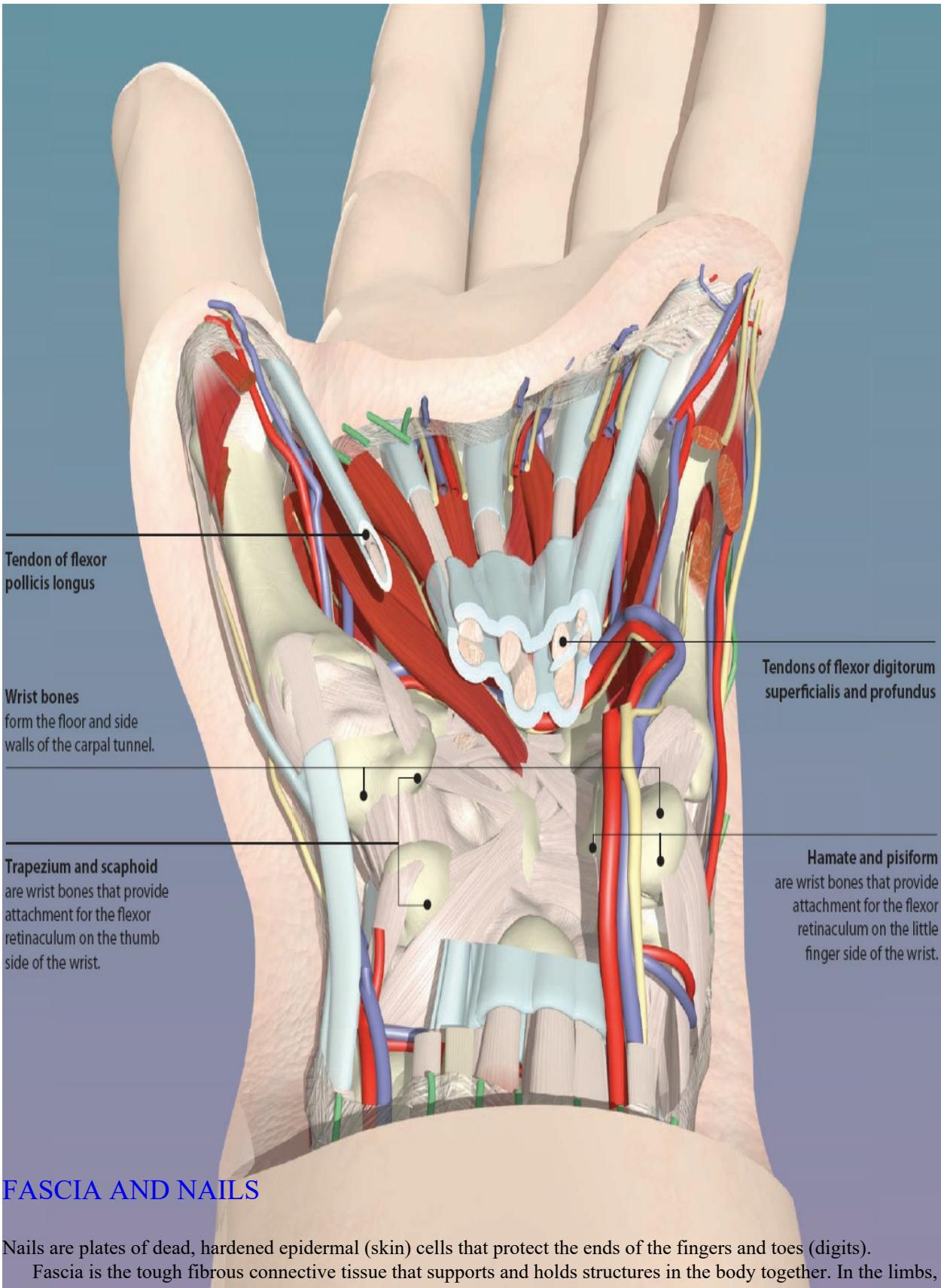
Synovial sheaths

Extensor retinaculum

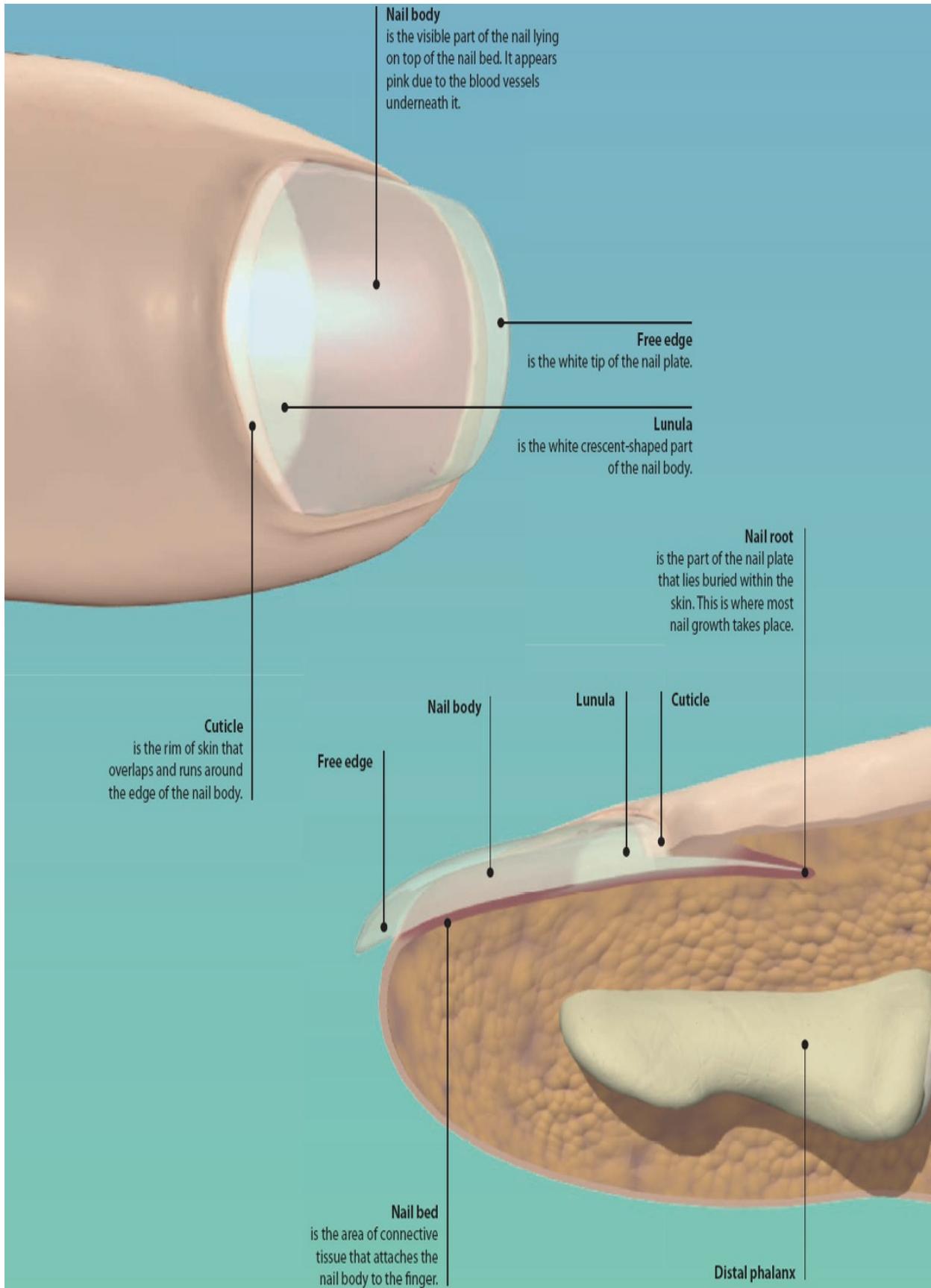
holds down and guides the tendons of the extensor muscles of the forearm.



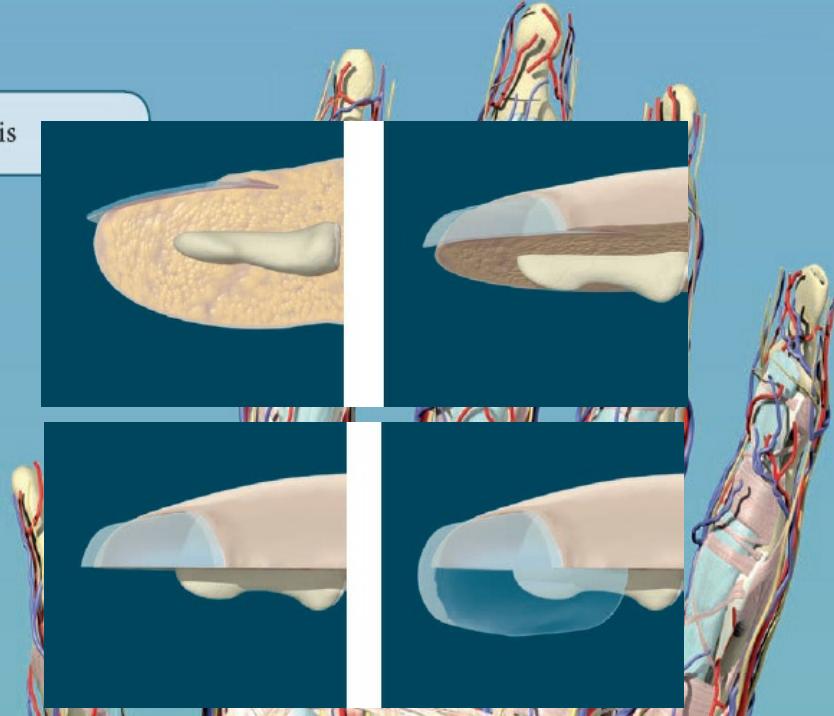




it separates muscles into groups that have similar actions. Fascia surrounds the muscles and allows them to move easily past each other. In certain parts of the body, the fascia is thickened to form distinct structures, such as the palmar aponeurosis.



Palmar Aponeurosis



Tendon of palmaris longus
muscle attaches into the
palmar aponeurosis.

Palmar aponeurosis
is a triangular-shaped
thickening of fascia in the
palm of the hand.

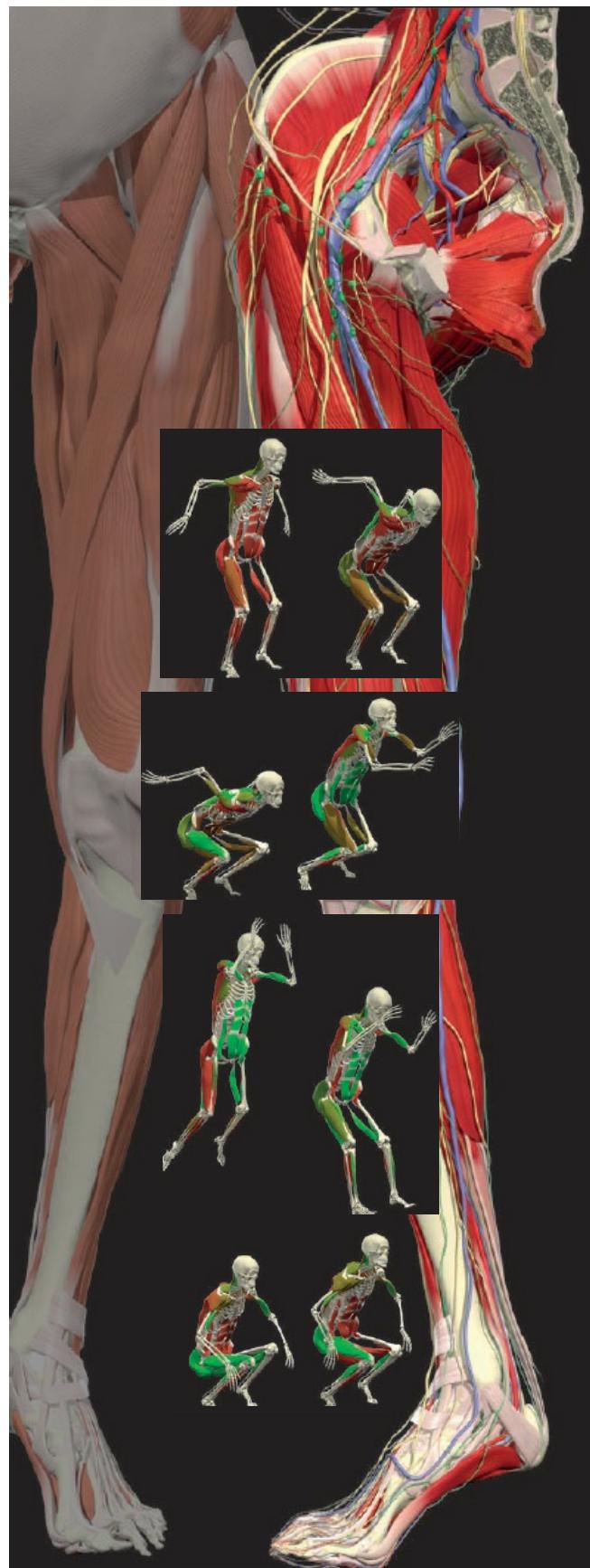
Palmaris brevis
muscle attaches to the
palmar aponeurosis. It
helps improve the grip on
smooth objects.

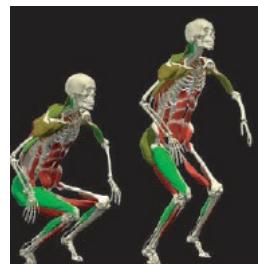
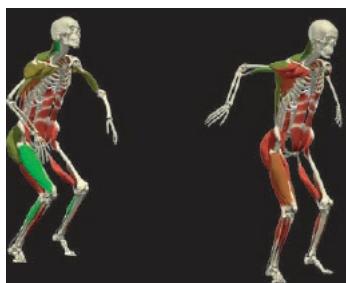
CHAPTER 8: THE LOWER LIMB

The lower limbs are attached to the trunk by strong joints between the hip bones and sacrum. The lower limb is made up of the femur (thigh bone), tibia (shin bone), fibula, and various smaller bones of the ankle and foot. It can be divided into five regions; the hip, thigh, knee, leg, and foot.

The lower limbs support the weight of the body and allow us to walk, run, and jump. This requires stable but mobile joints, along with strong muscles acting across them.

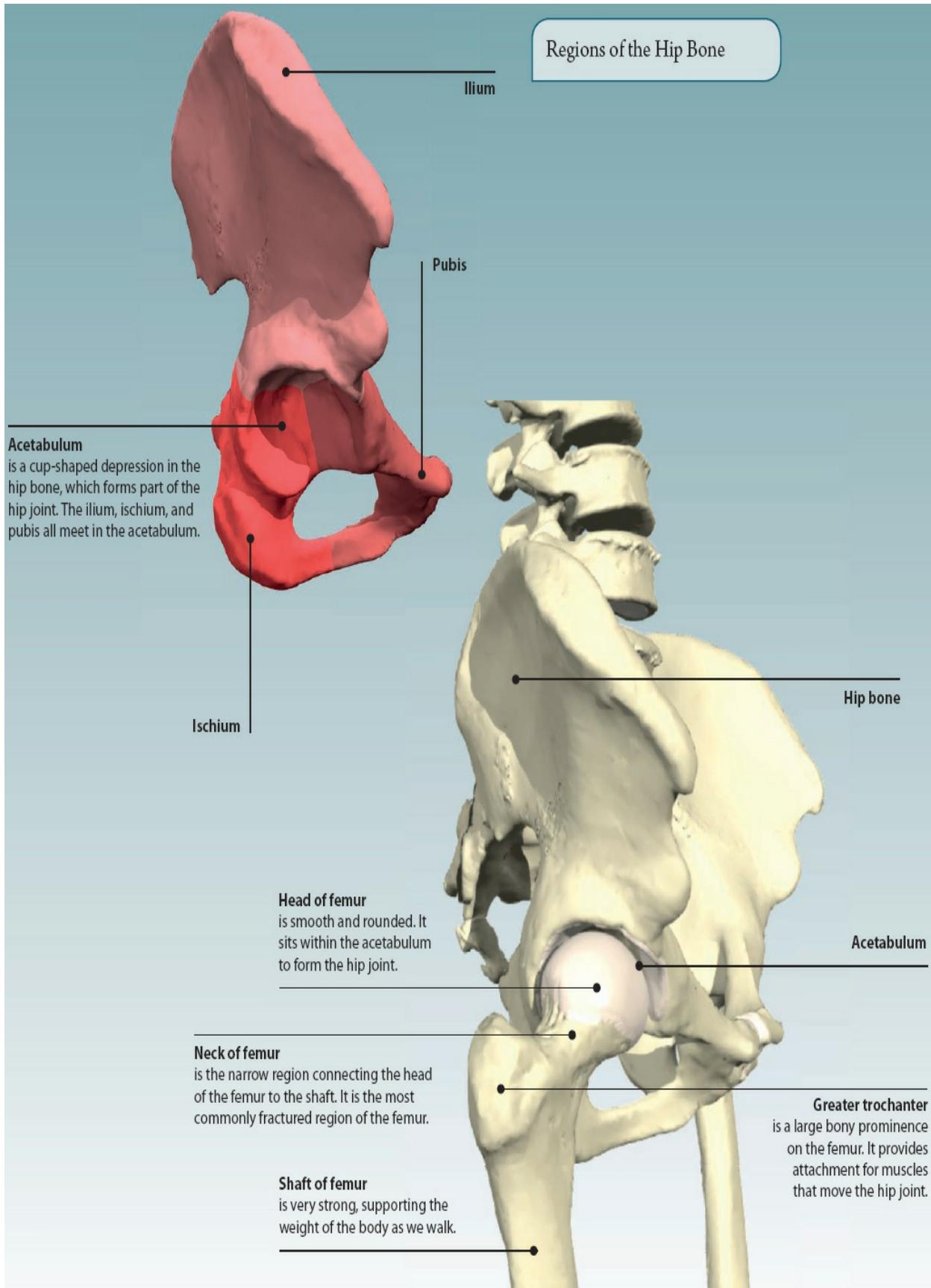


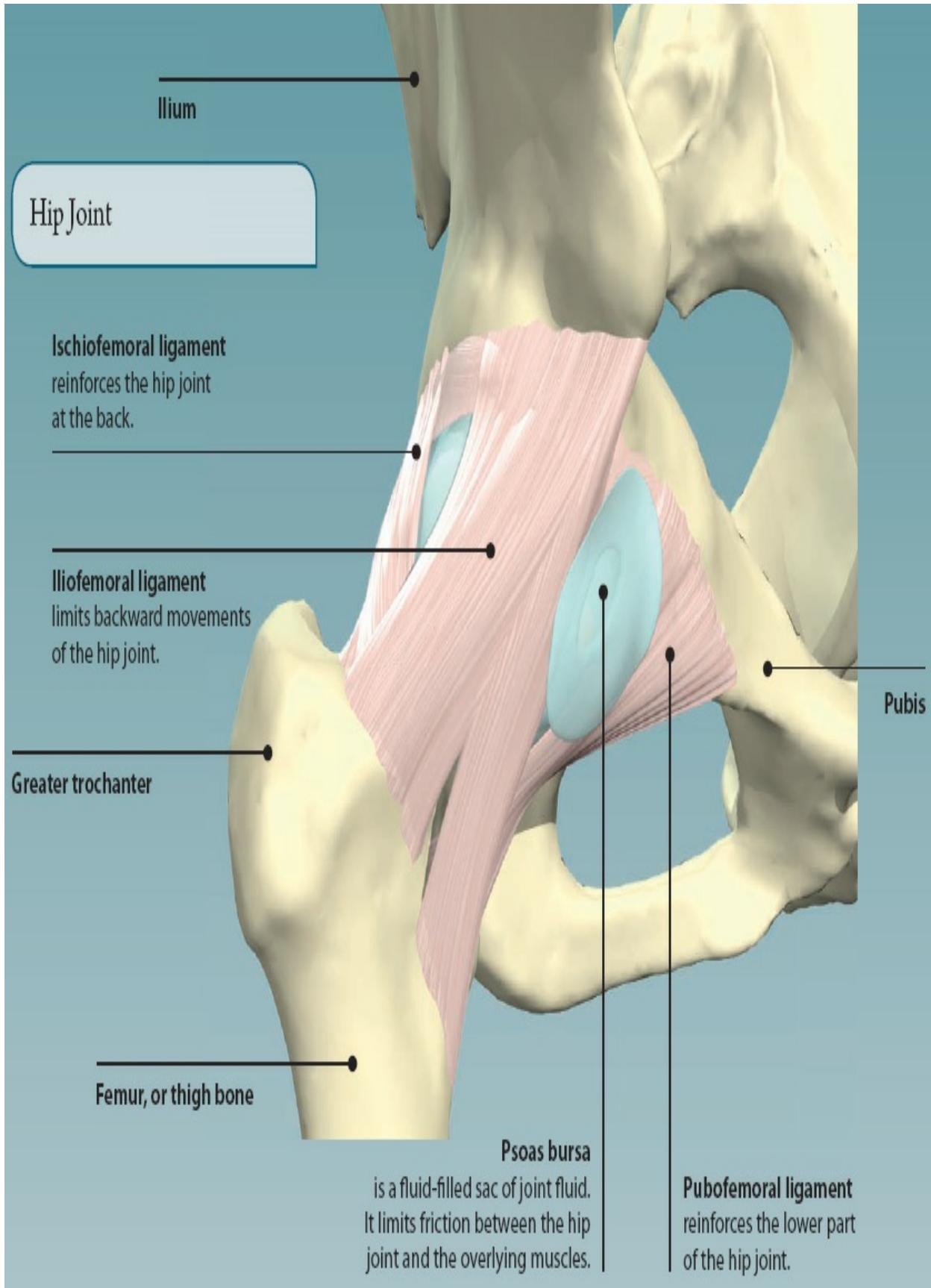


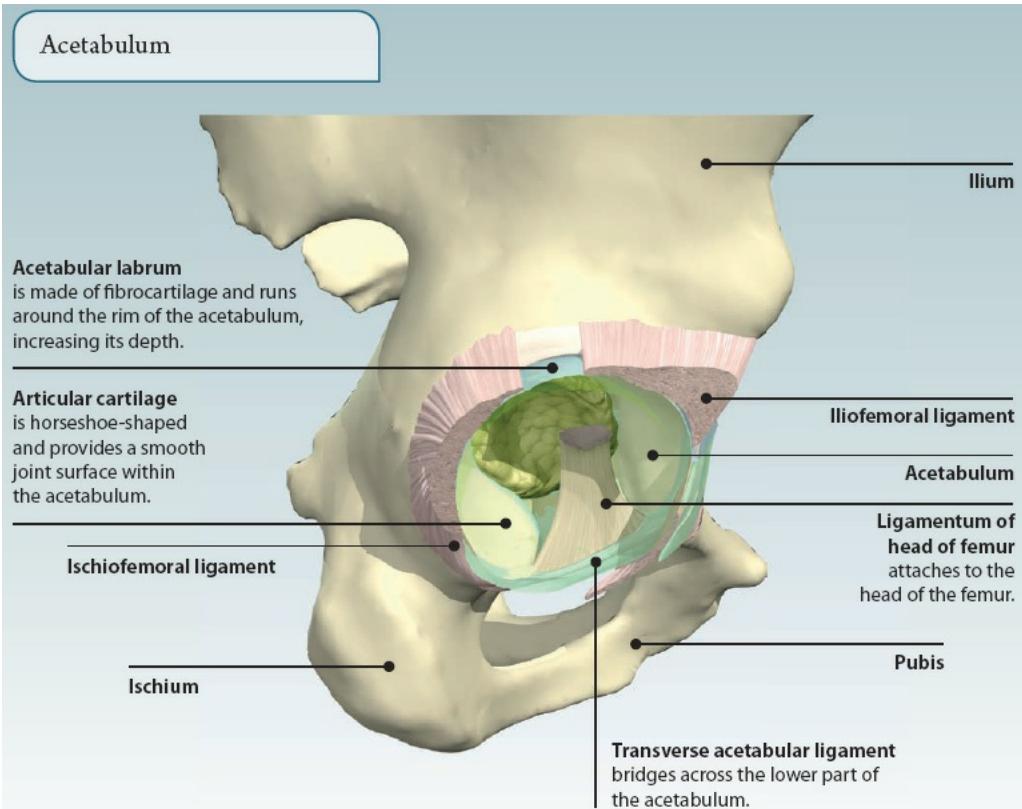


THE HIP JOINT

The hip joint is a ball and socket joint. It is formed as the round head of the femur sits within the cup-shaped acetabulum of the hip bone. It is a strong but mobile joint, and can be moved forward, backward, and sideways, as well as allowing some rotation. Movements are limited by various ligaments, which strengthen and stabilize the joint.









MUSCLES OF THE HIP AND THIGH

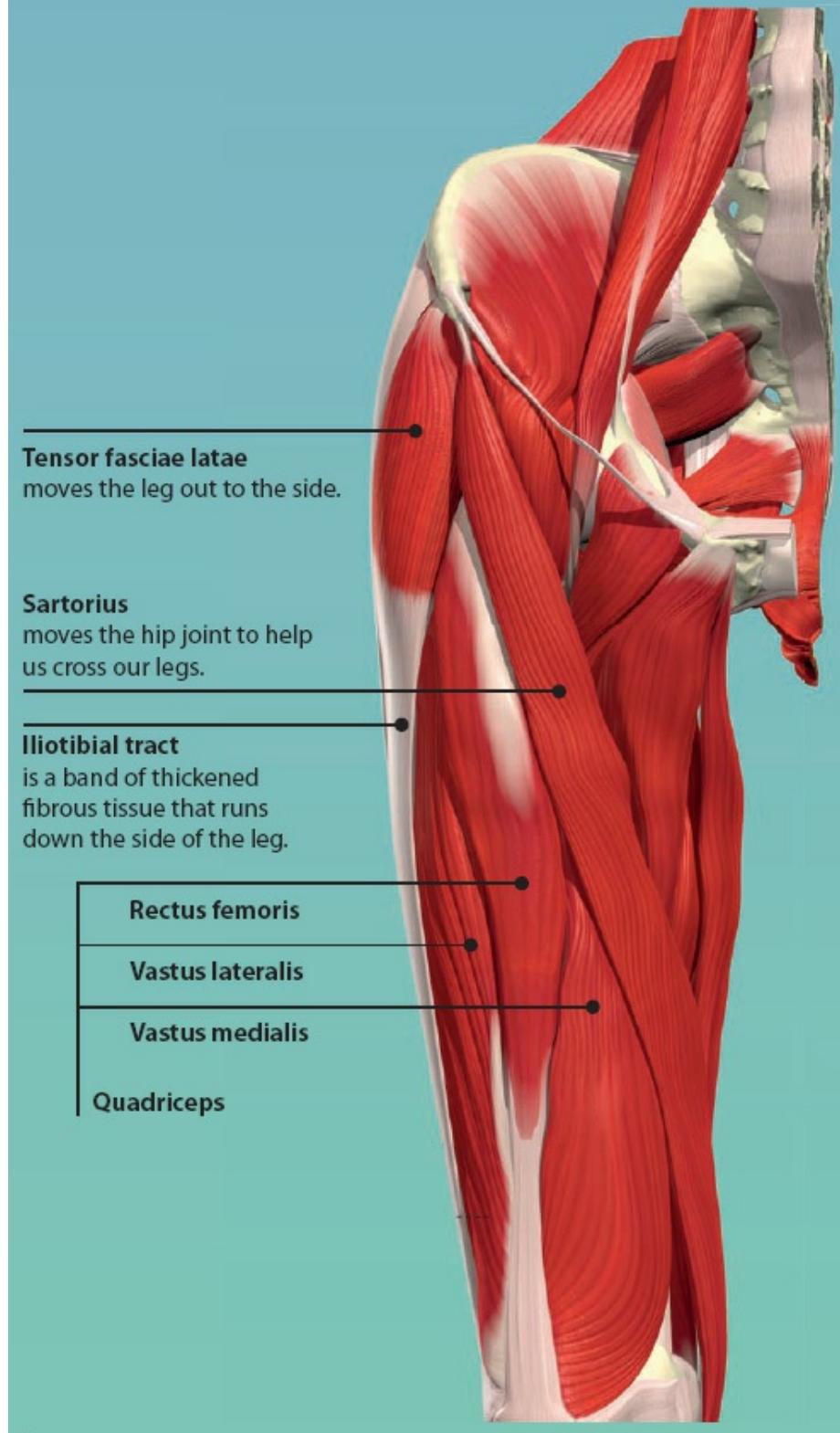
The hip is the region of the lower limb around the hip bone. The thigh is the region of the lower limb between the hip and the knee. Strong muscles in these regions move the hip and knee joints, allowing us to walk.

The thigh can be divided into three main compartments (anterior, posterior, and medial) whose muscles all have similar actions at the hip or knee joints.

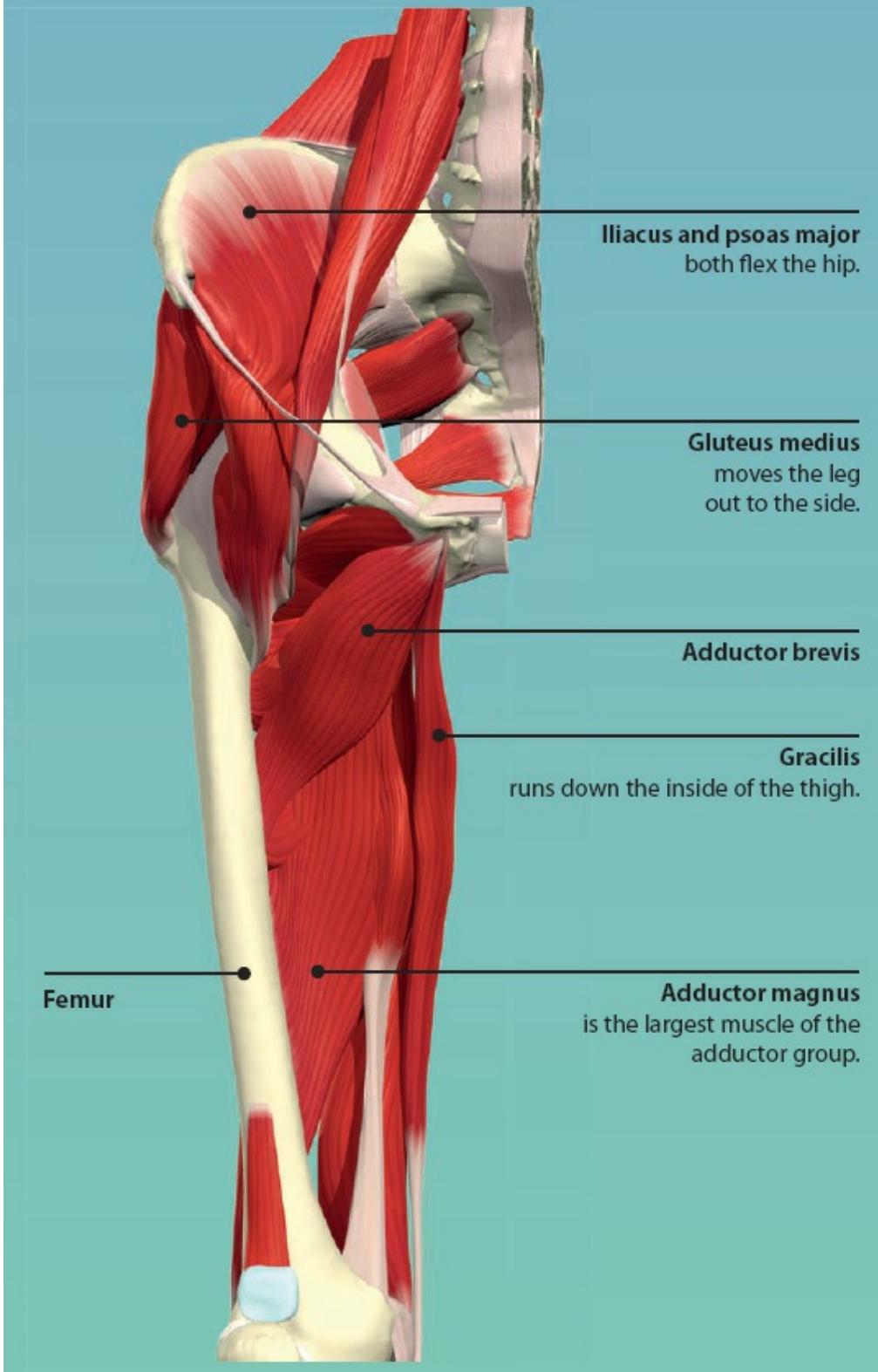
Did you know?

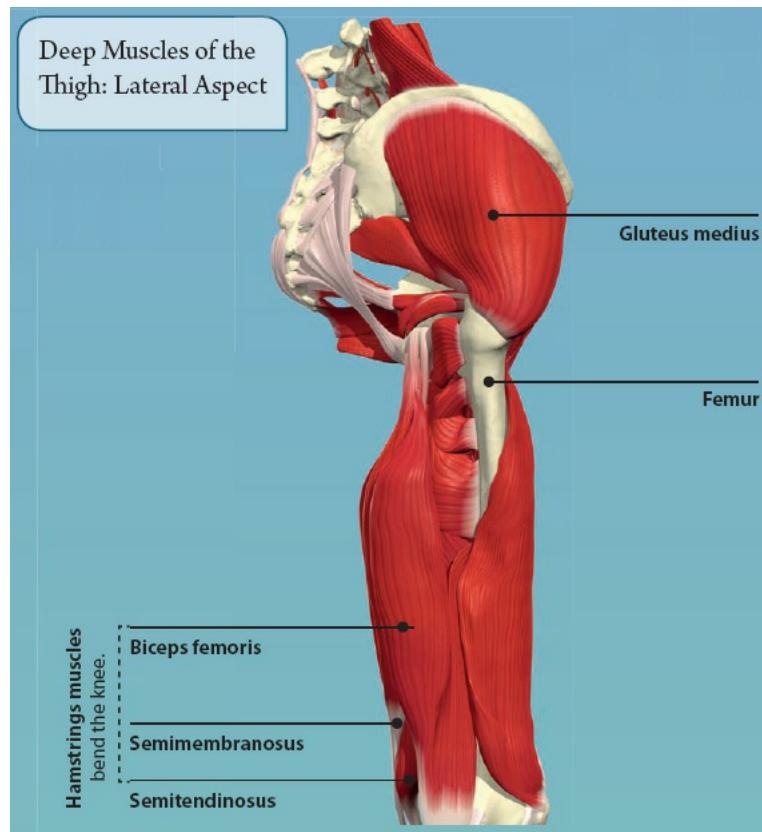
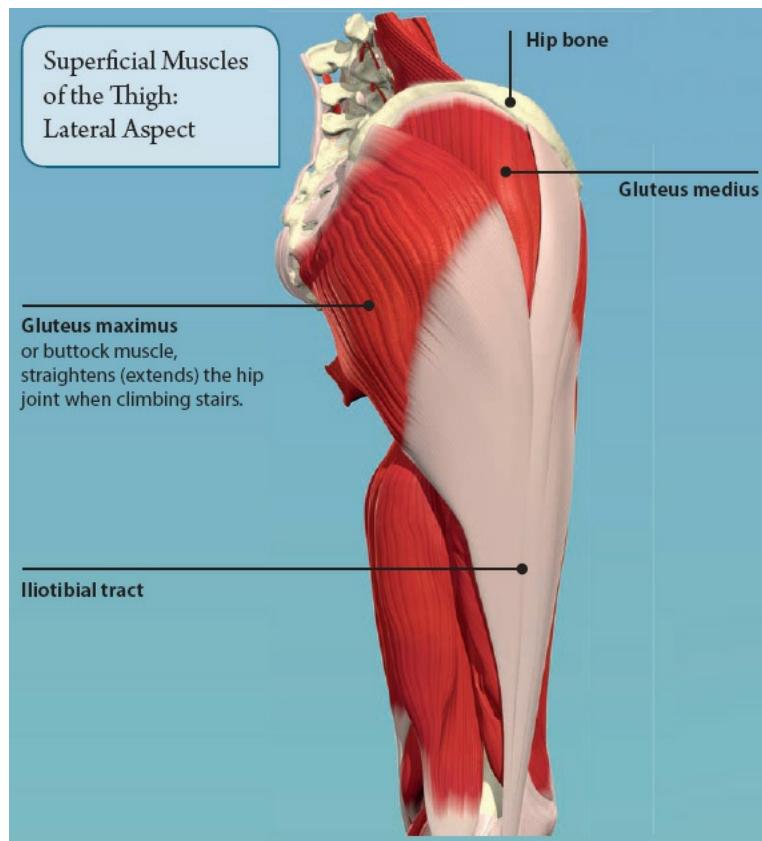
Vastus medialis forms the muscular bulge just above the inside of the knee when it is straightened. It is often the first muscle to shrink in size (atrophy) if the limb is injured and cannot be exercised.

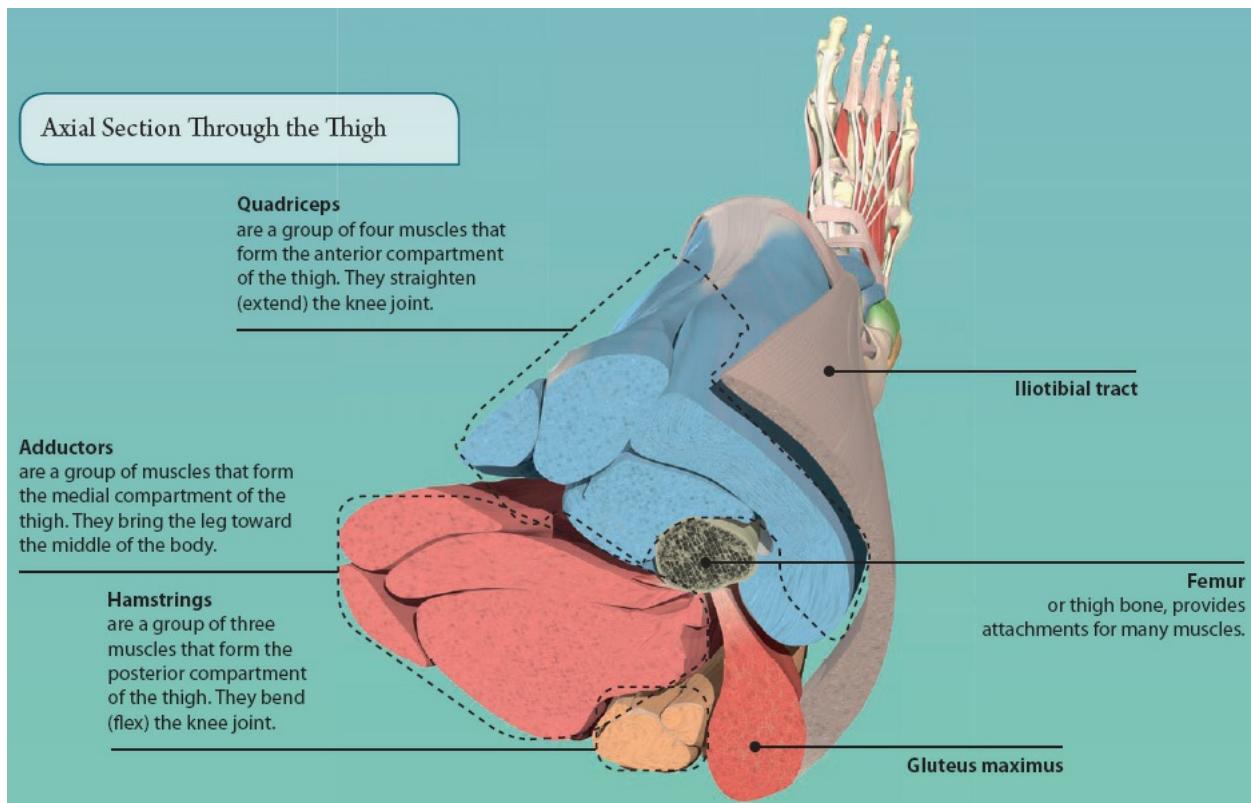
Superficial Muscles of the Thigh: Anterior Aspect



Deep Muscles of the Thigh: Anterior Aspect







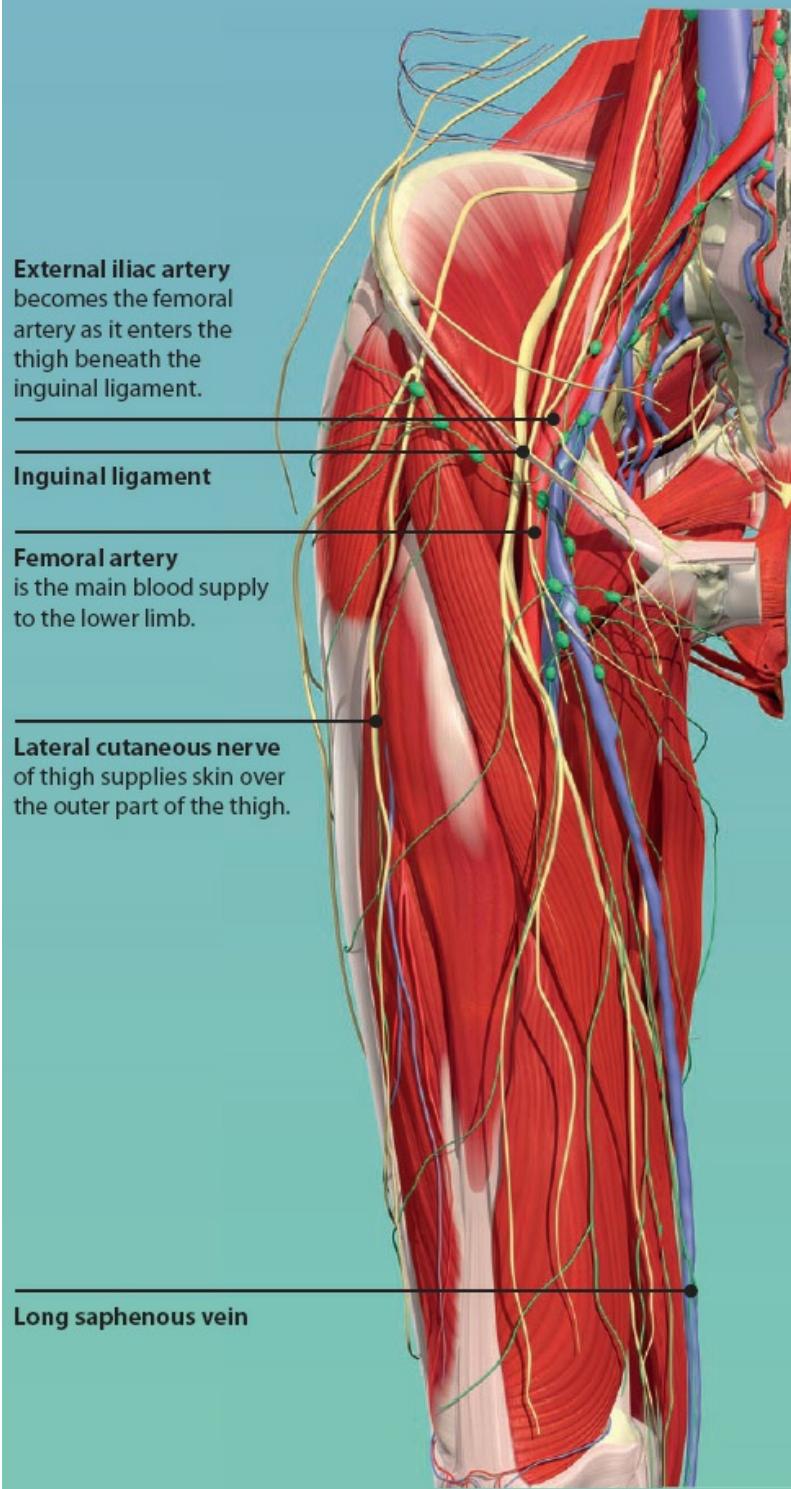
NEUROVASCULAR STRUCTURES OF THE HIP AND THIGH

Blood is distributed to the hip and thigh by branches of the internal and external iliac vessels. Various nerves travel through the hip and thigh, supplying the muscles and skin of the lower limb.

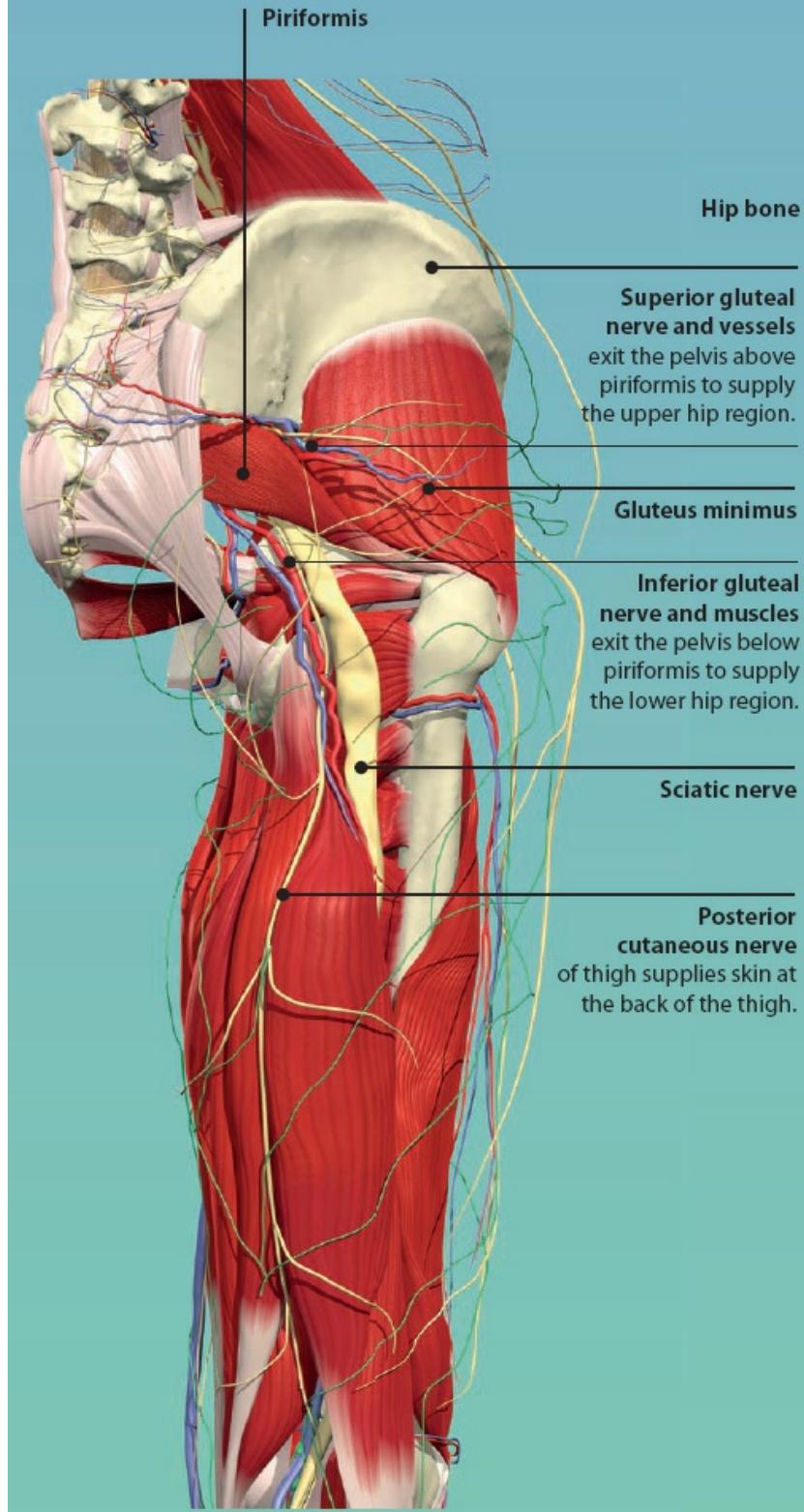
Did you know?

If the nerve roots that supply the sciatic nerve become trapped or irritated in the lower back, the sensation of pain often radiates down the entire lower limb to the foot. This is known as sciatica.

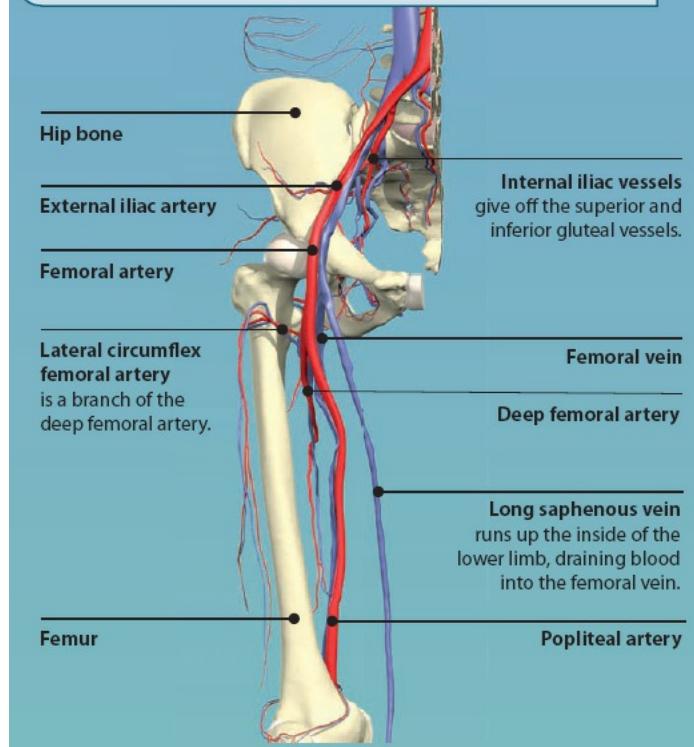
Neurovascular structures and Muscles
of the Thigh: Anterior Aspect



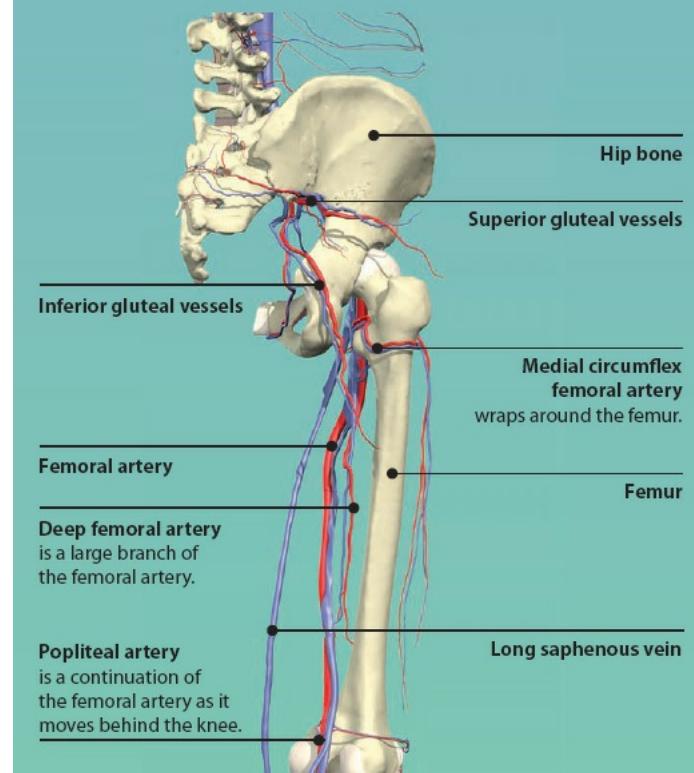
Neurovascular Structures and Muscles of the Thigh: Posterior Aspec



Neurovascular Structures of the Thigh: Anterior Aspect



Neurovascular Structures of the Thigh: Posterior Aspect



Nerves of the Hip and Thigh



Sciatic nerve

is the largest nerve in the body. It supplies the hamstring muscles before dividing into the common fibular and tibial nerves.



Obturator nerve

innervates the adductor muscles on the inner thigh.



Femoral nerve

innervates the quadriceps muscles.



Saphenous nerve

is a continuation of the femoral nerve. It supplies sensation over the inner part of the shin.



Common fibular nerve

supplies muscles that lift the toes.



Tibial nerve

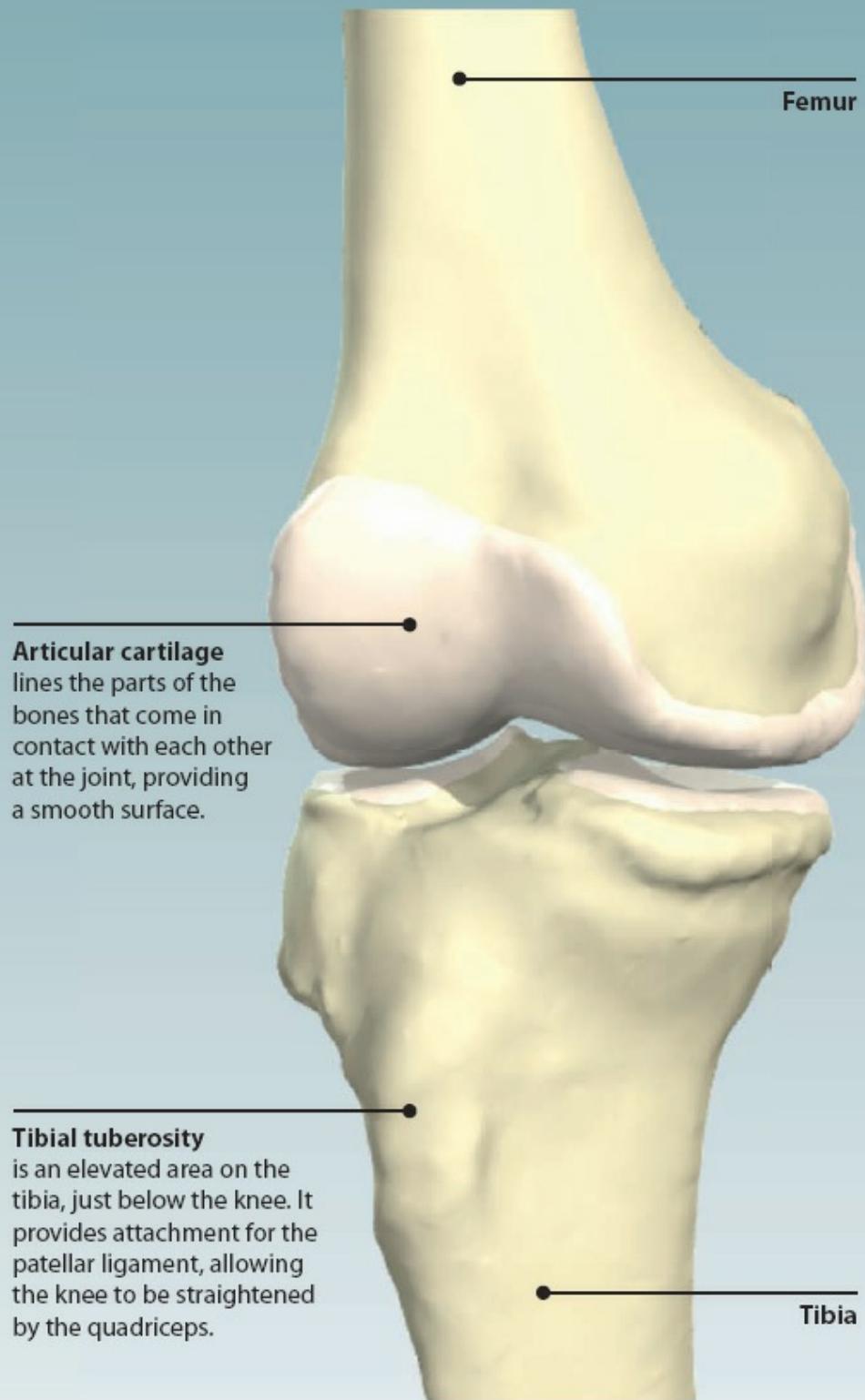
supplies the calf muscles at the back of the lower leg.

KNEE JOINT

The knee joint is a complex hinge joint, formed between the femur (thigh bone), tibia (shin bone), and patella (kneecap).

The main movements at the knee are flexion (bending) and extension (straightening), along with a small degree of rotation.

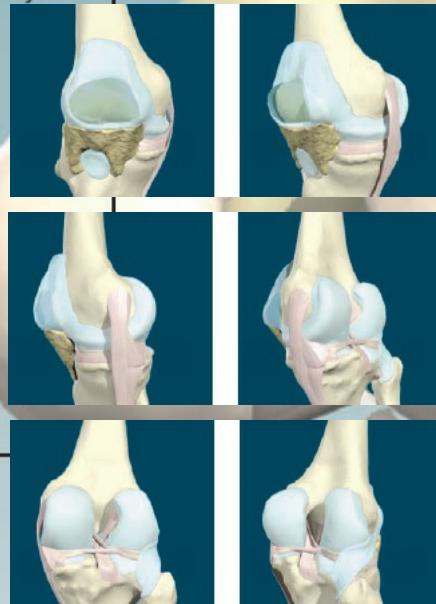
Bones of the Knee: Anterior Aspect



Bones of the Knee: Posterior Aspect

Femur

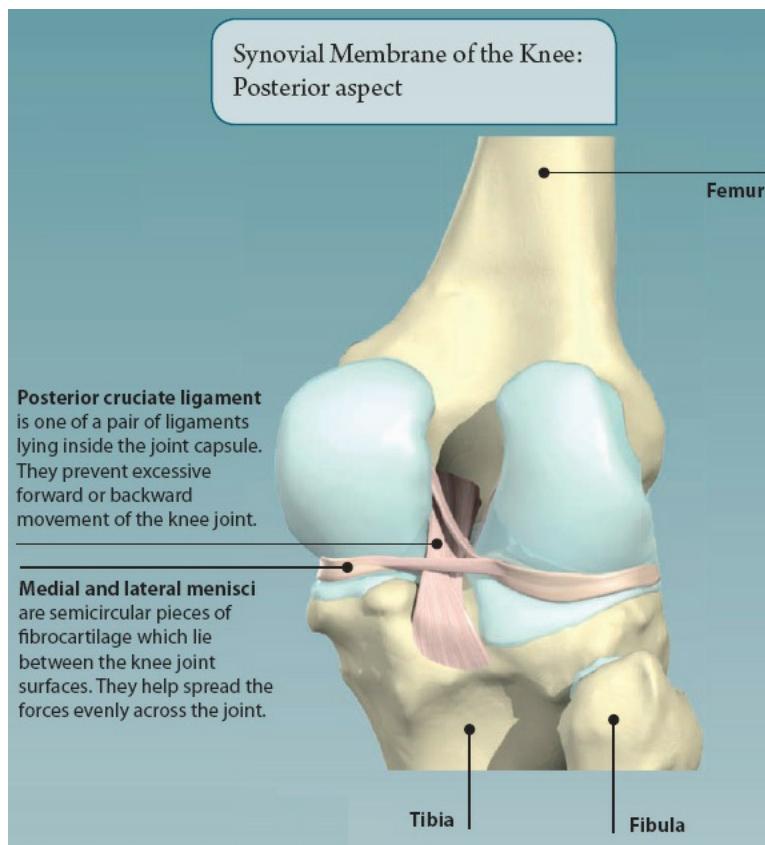
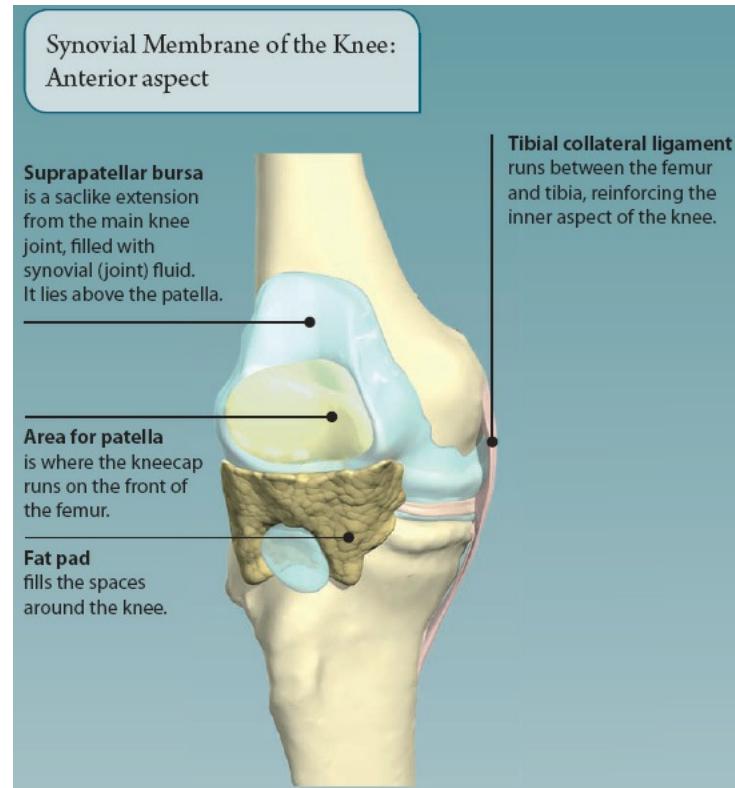
Femoral condyles are the expanded lower ends of the femur that form part of the knee joint.

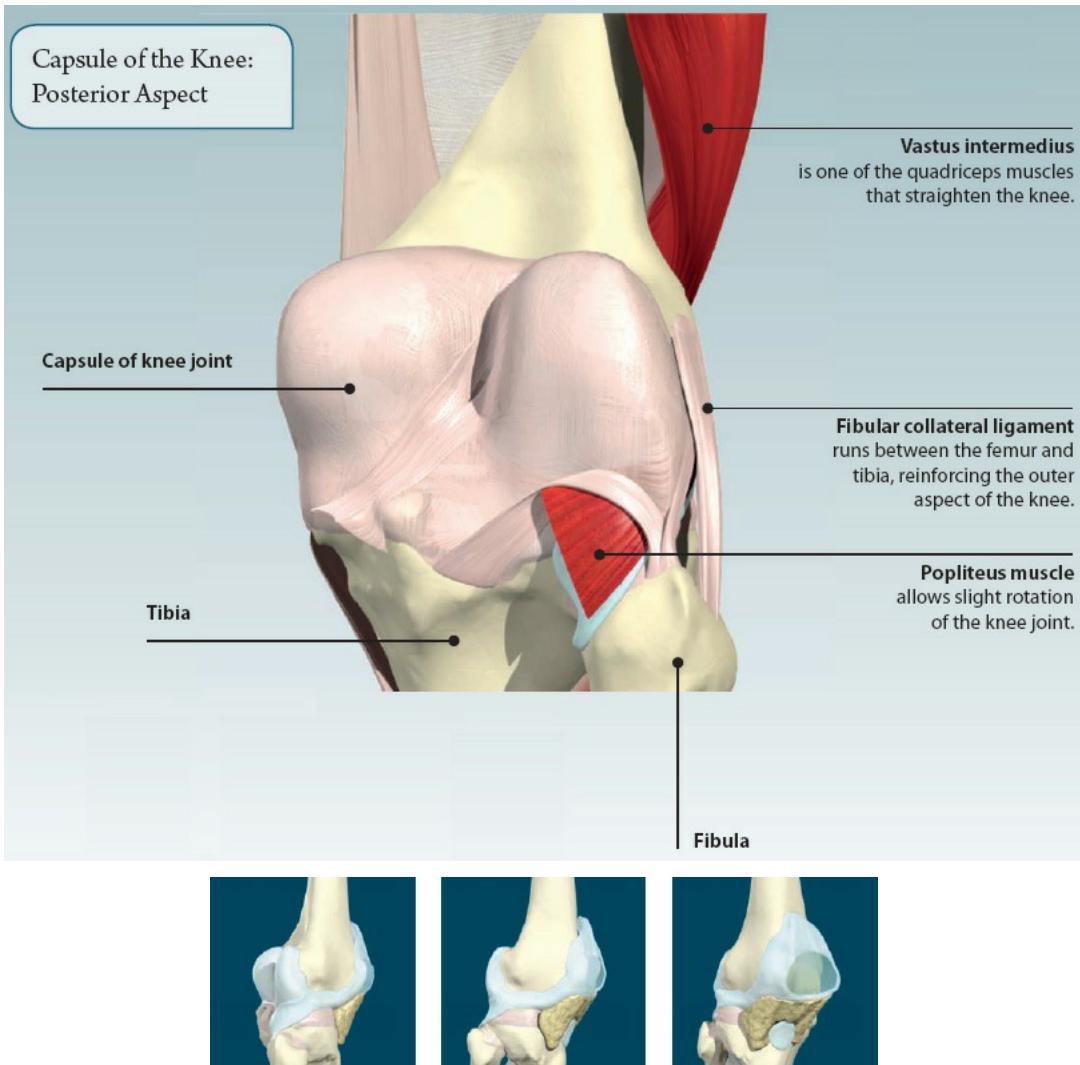


Tibial plateau is the flattened upper part of the tibia, which forms part of the knee joint.

Tibia

Fibula

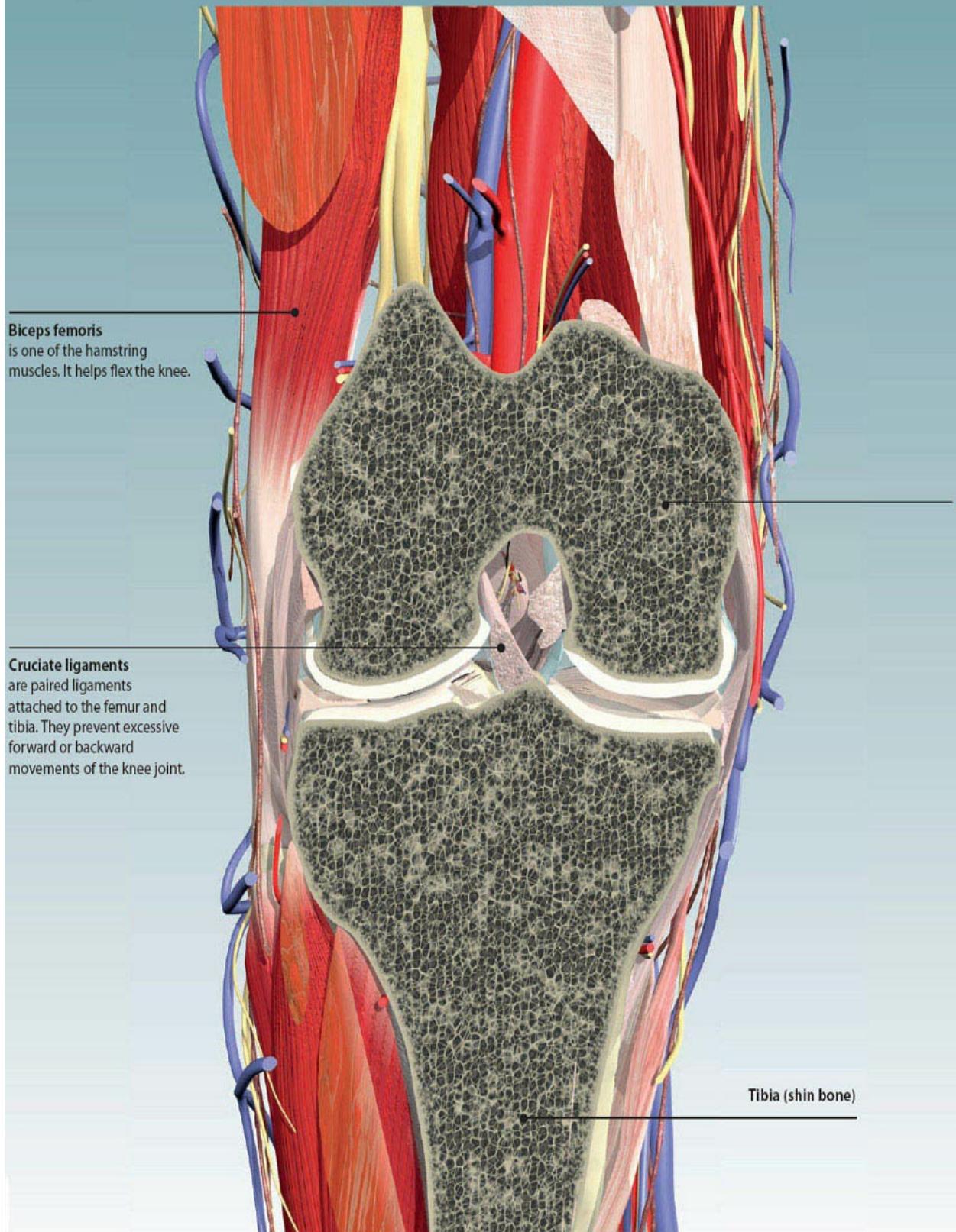


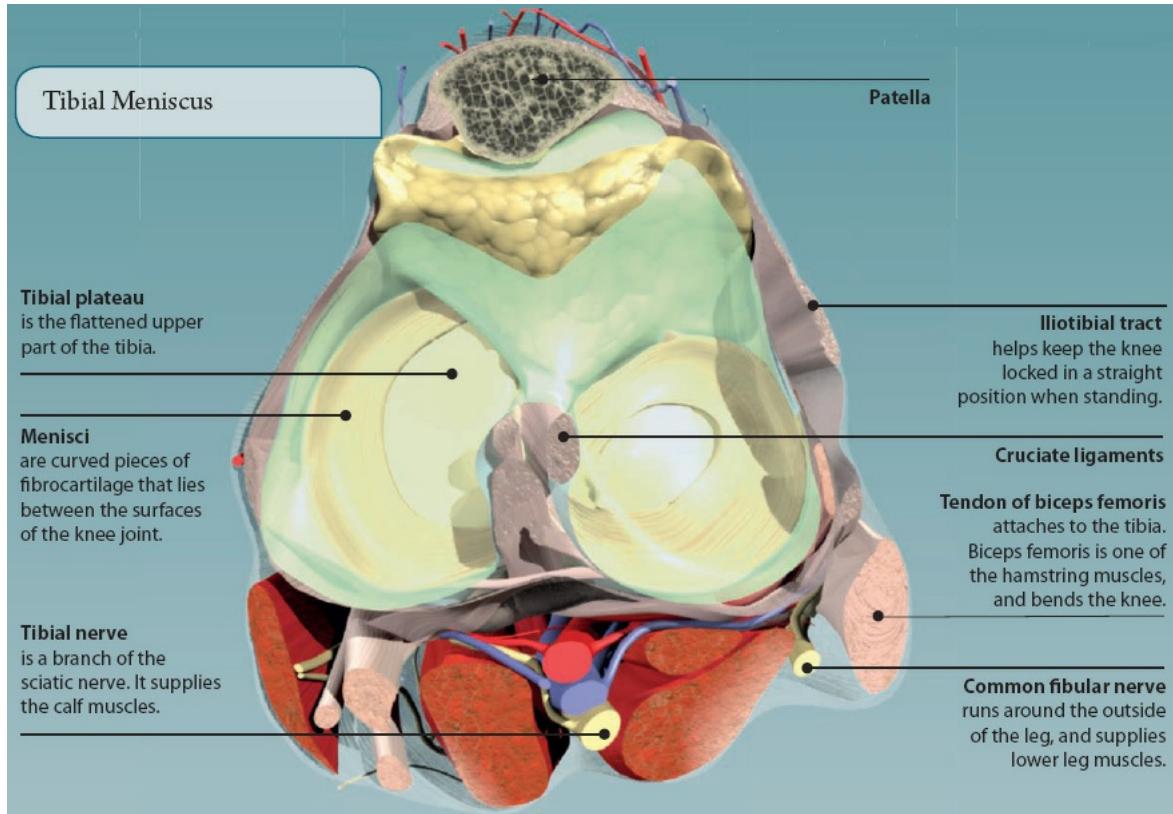


MUSCLES CROSSING THE KNEE

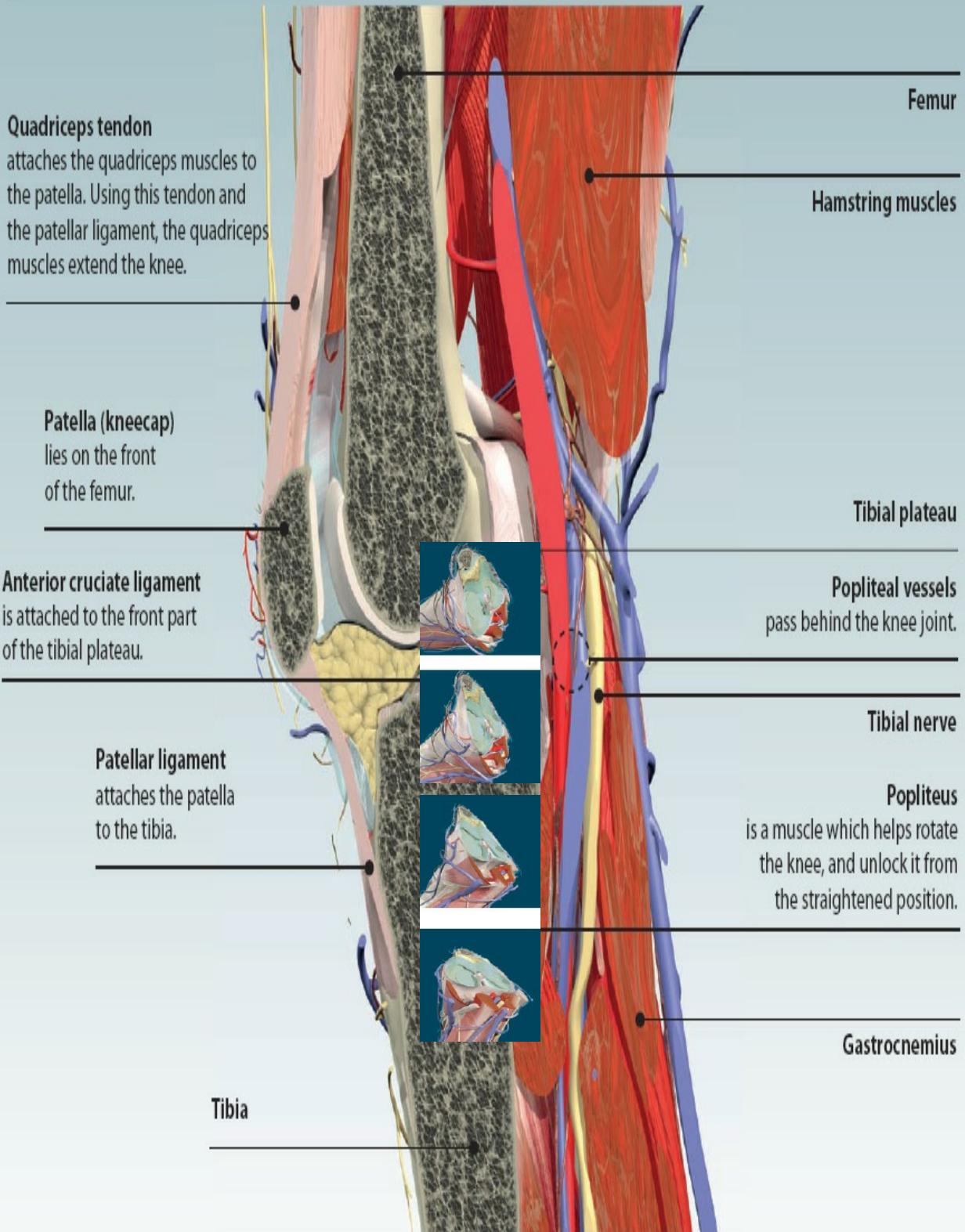
The knee is the region of the lower limb between the thigh and lower leg. Muscles crossing the knee allow movement to take place at the joint. The main movements are flexion (bending) and extension (straightening), along with a small amount of rotation.

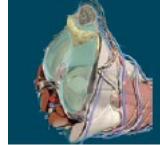
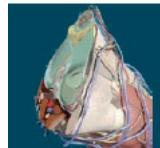
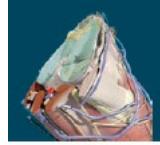
Coronal Section of the Knee





Sagittal Section of the Knee





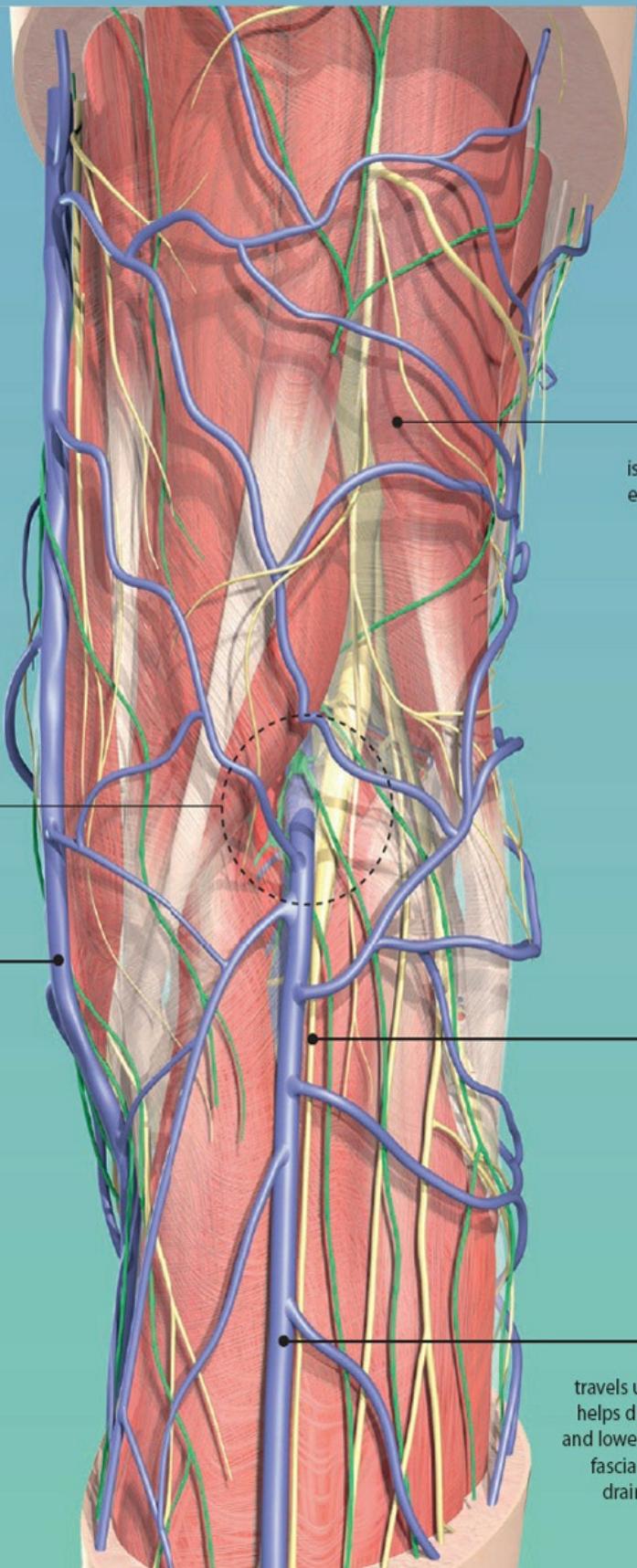
POPLITEAL FOSSA DISSECTION

The popliteal fossa is the diamond-shaped hollow at the back of the knee. Its boundaries are formed by muscles of the back of the thigh (hamstrings) and lower leg (calf). It contains blood vessels, nerves, and lymph nodes, traveling to and from the lower leg.

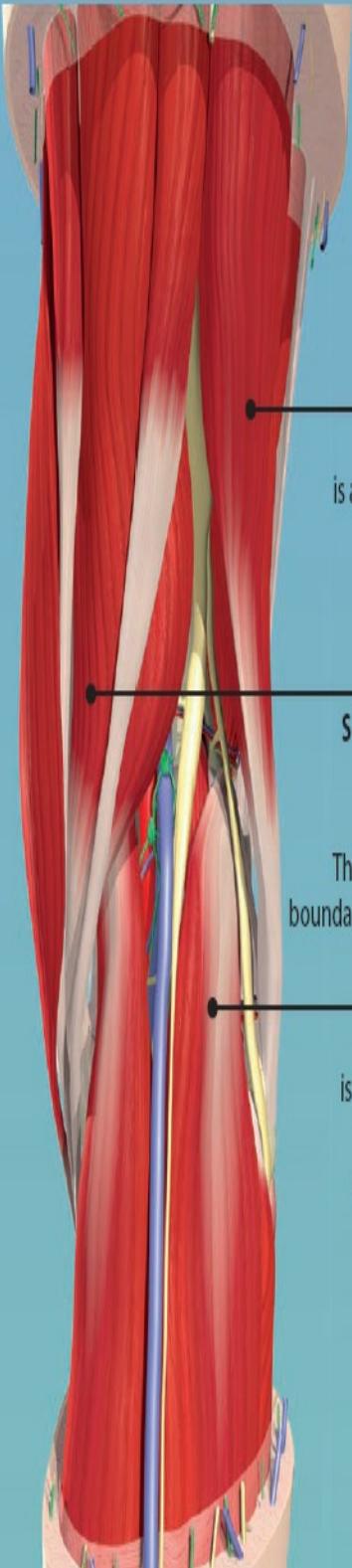
Did you know?

The sural nerve can be used as a nerve graft to repair damaged nerves elsewhere in the body. It is often chosen because it does not supply any muscles, and the area of skin it supplies is relatively small on the back of the leg.

Popliteal Fossa



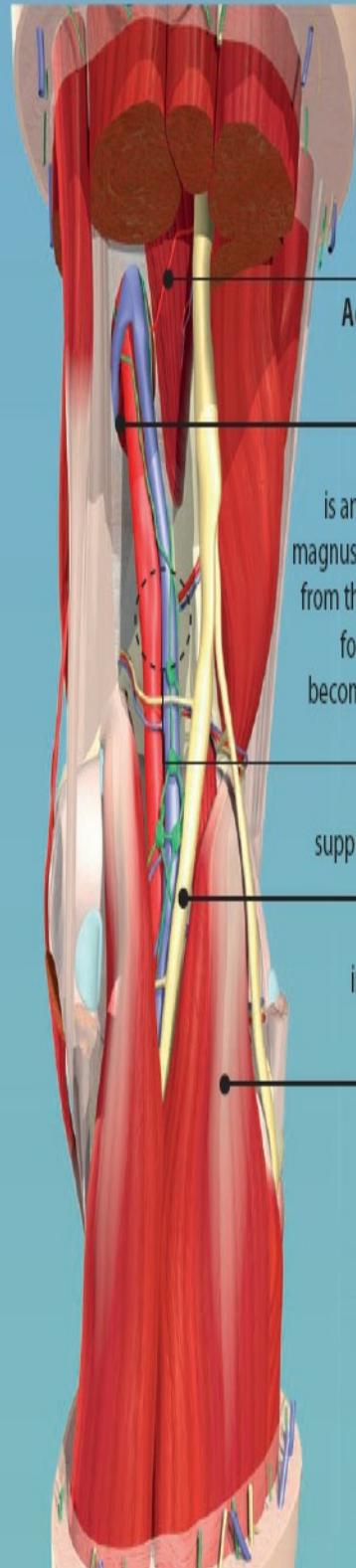
Popliteal Fossa Dissection



Biceps femoris
is a hamstring muscle that forms the upper outer boundary of the popliteal fossa.

Semimembranosus and semitendinosus
are hamstring muscles.
They form the upper inner boundary of the popliteal fossa.

Gastrocnemius
is one of the calf muscles.
Its two heads form the lower boundaries of the popliteal fossa.



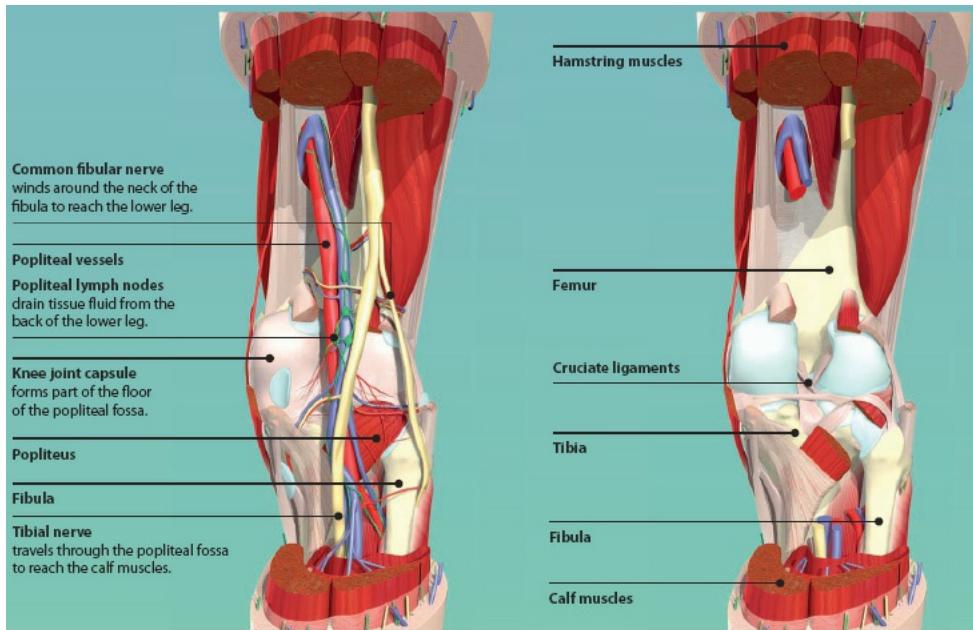
Adductor magnus muscle
helps flex the knee joint.

Adductor hiatus
is an opening in the adductor magnus. The femoral vessels pass from the thigh into the popliteal fossa through this opening, becoming the popliteal vessels.

Popliteal vessels
supply the knee and lower leg.

Sciatic nerve
innervates the hamstrings and lower leg muscles.

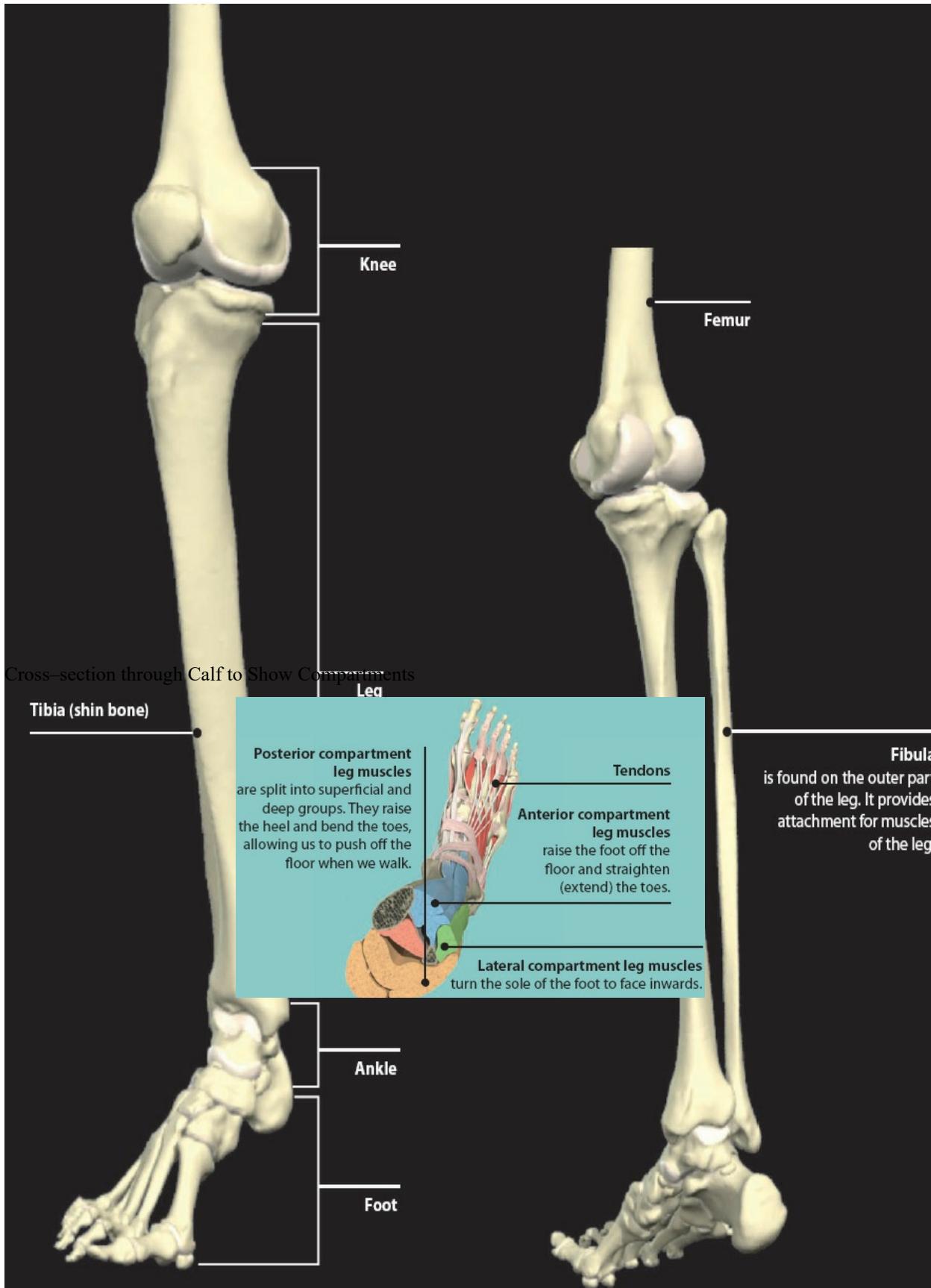
Gastrocnemius

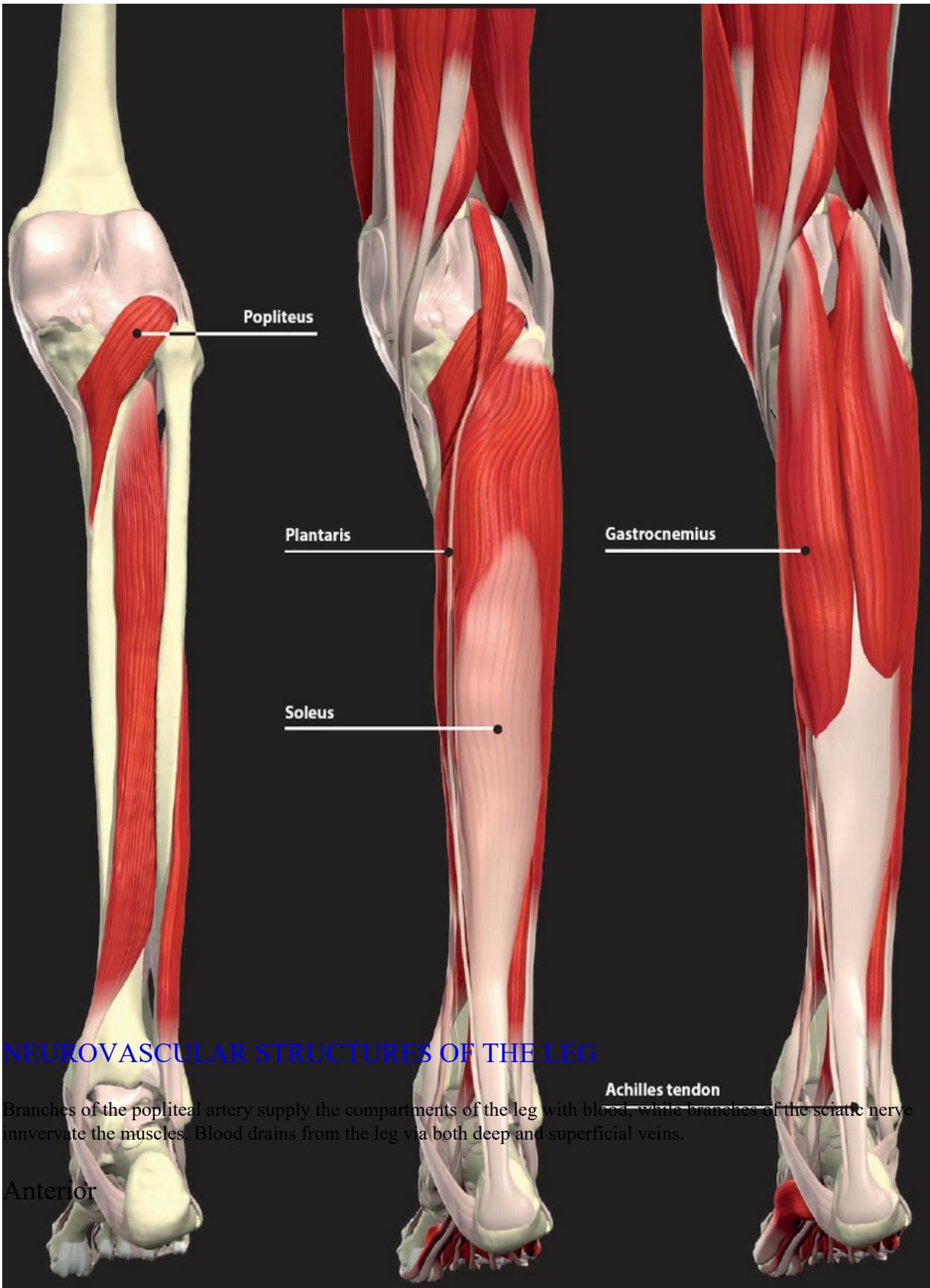


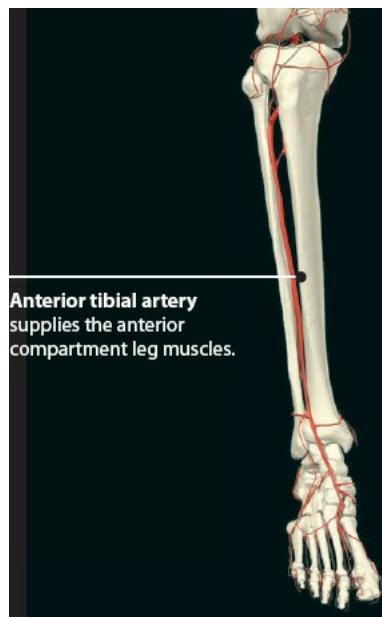
BONES AND MUSCLES OF THE LEG

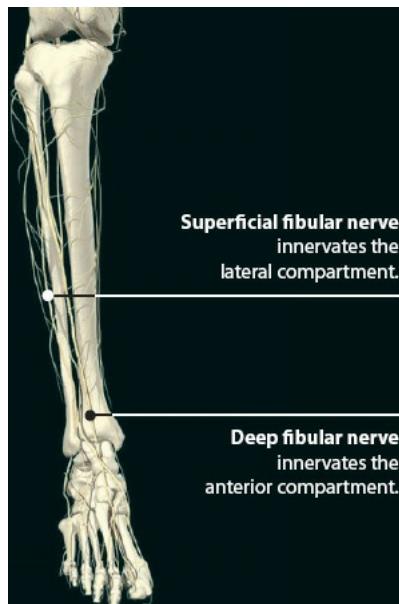
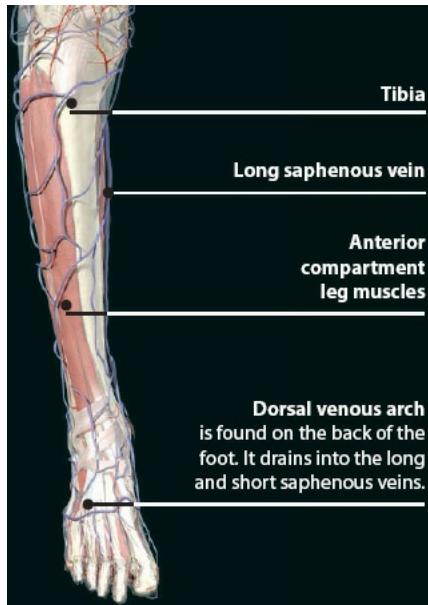
The leg is the region of the lower limb between the ankle and the knee, formed by the tibia (shin bone) and fibula.

The muscles of the leg are divided into three compartments. Their long tendons attach them to the foot bones, causing movement at the ankle and toe joints.

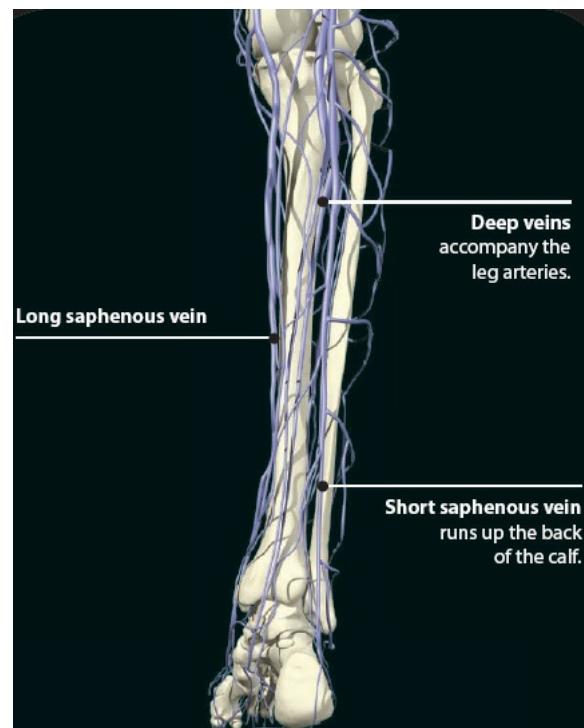
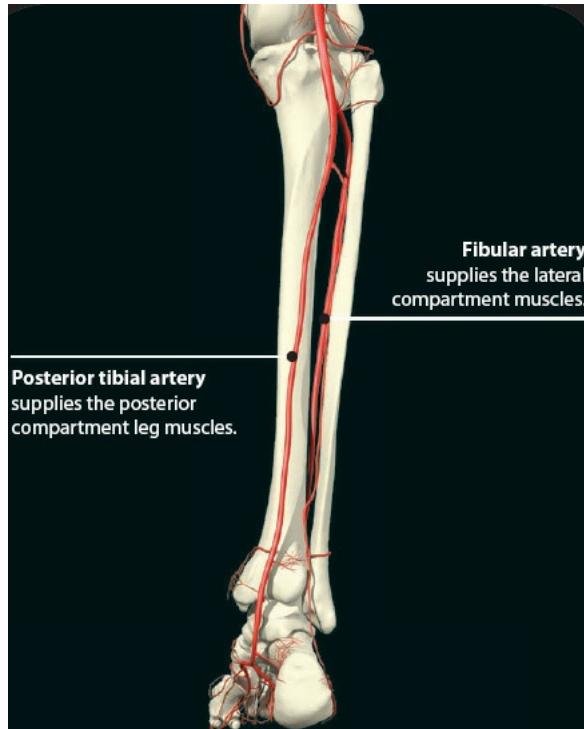


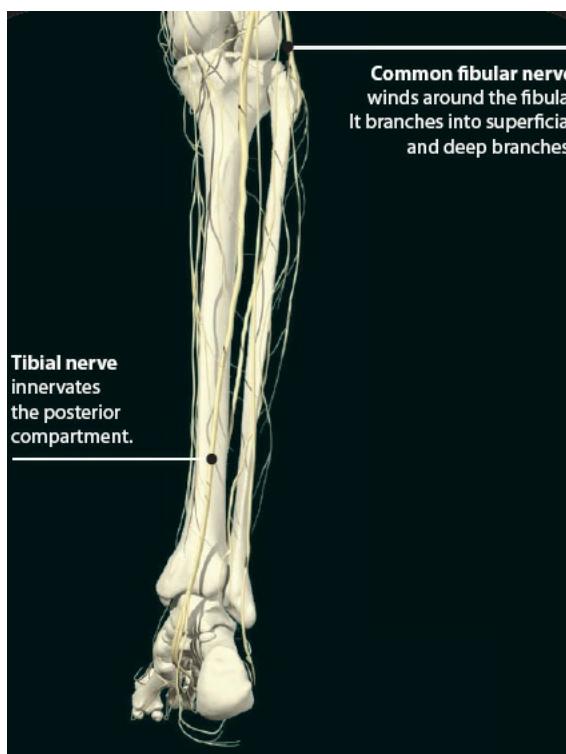
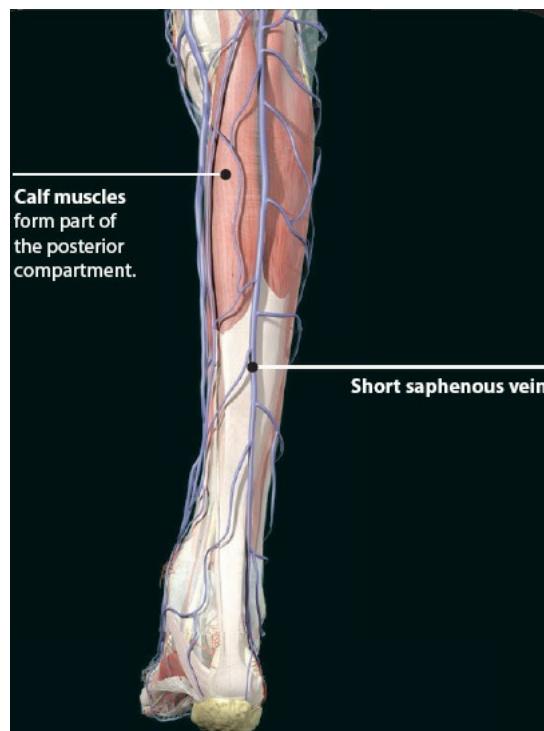






Posterior



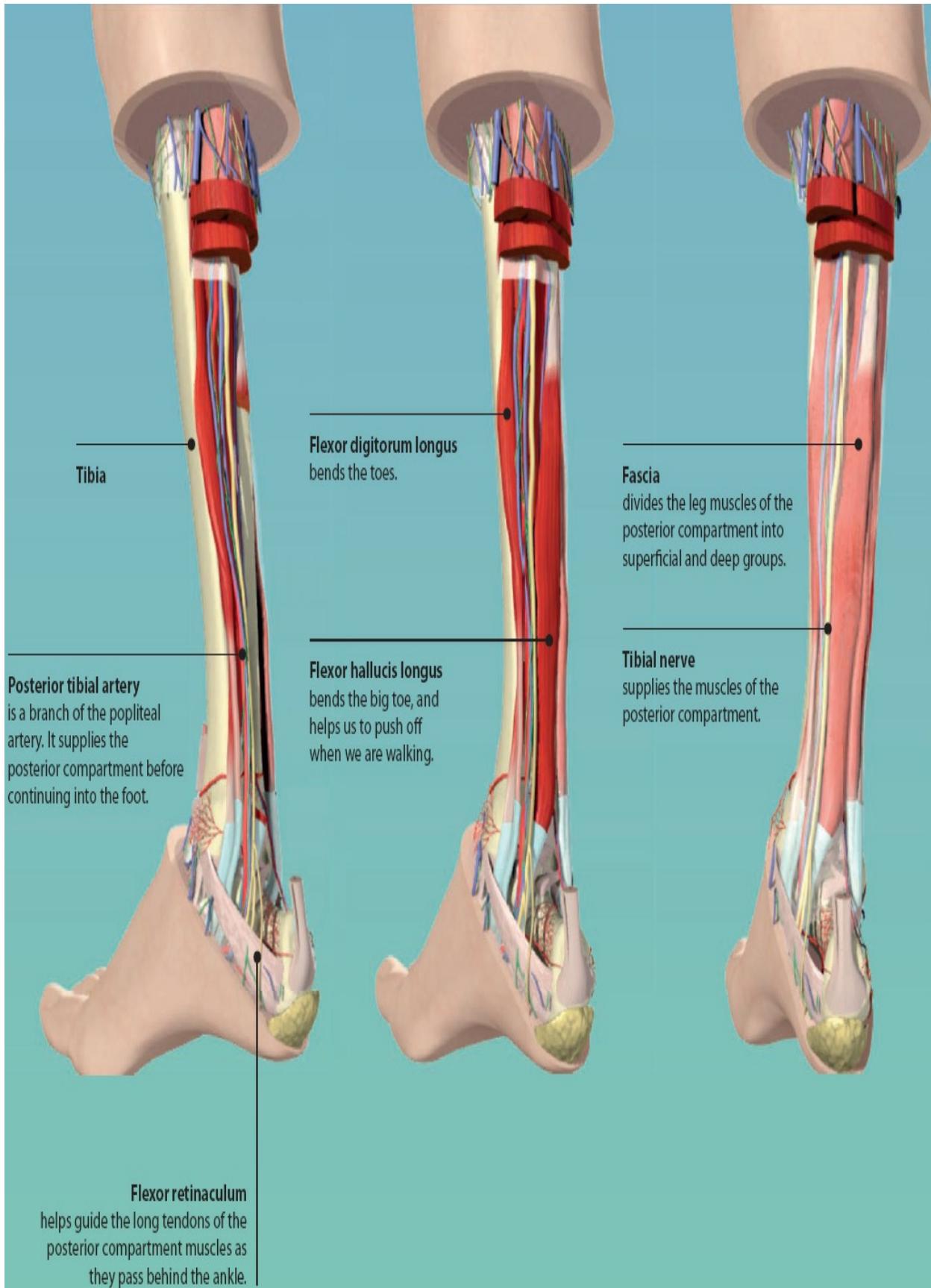


CALF DISSECTION

The calf is the back part of the leg, formed by the posterior compartment muscles. These muscles bend (flex) the toes, as well as raising the heel from the floor. They are divided into superficial and deep groups by a layer of fascia.

Did you know?

The ankle jerk is an involuntary reflex contraction of the calf muscles when the Achilles tendon is tapped with a tendon hammer. The ankle jerk can be used by doctors to assess if the nerves supplying the calf muscles are intact.

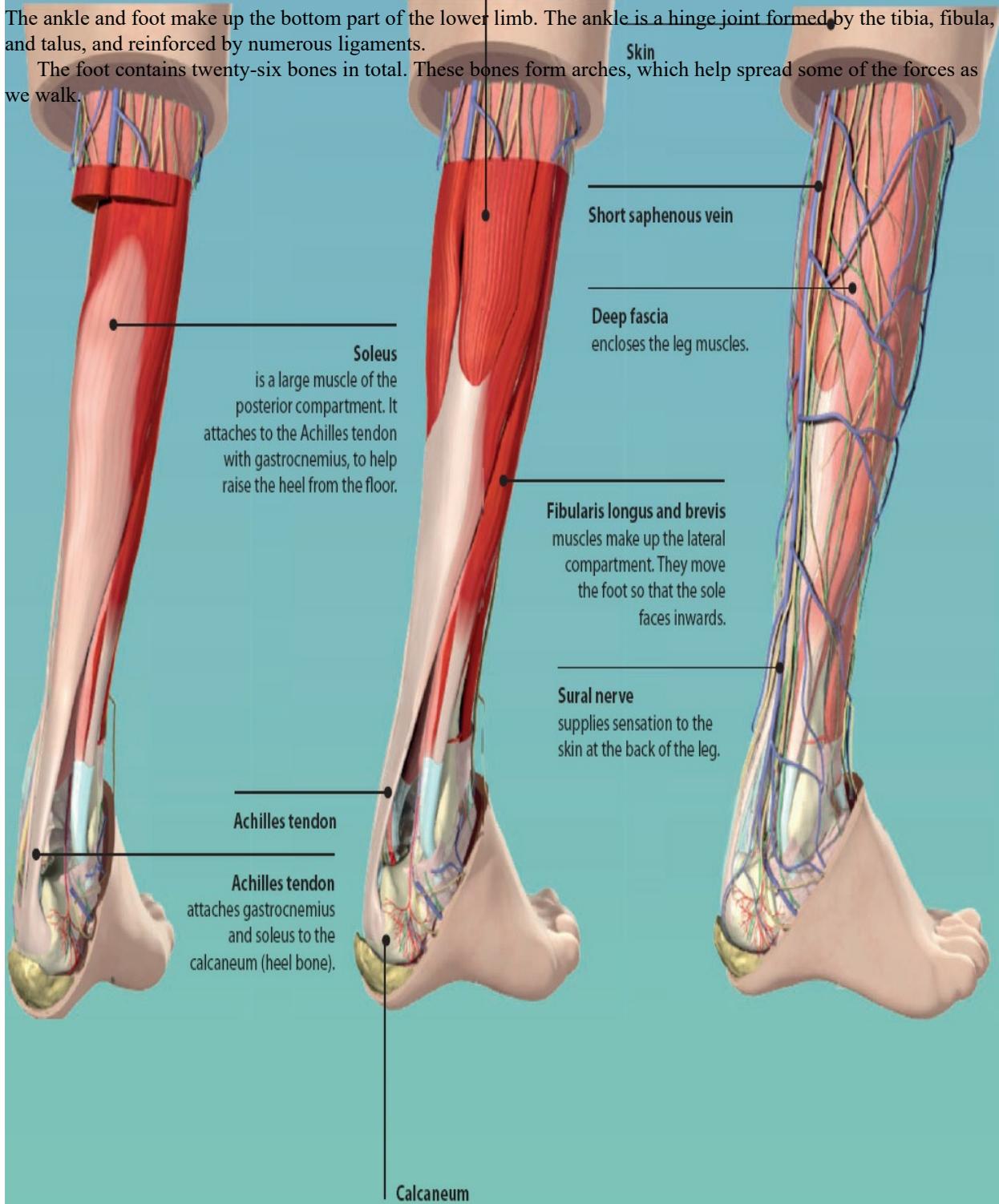


Gastrocnemius
muscle, along with soleus, forms
the superficial group of the
posterior compartment.

BONES AND LIGAMENTS OF THE FOOT AND ANKLE

The ankle and foot make up the bottom part of the lower limb. The ankle is a hinge joint formed by the tibia, fibula, and talus, and reinforced by numerous ligaments.

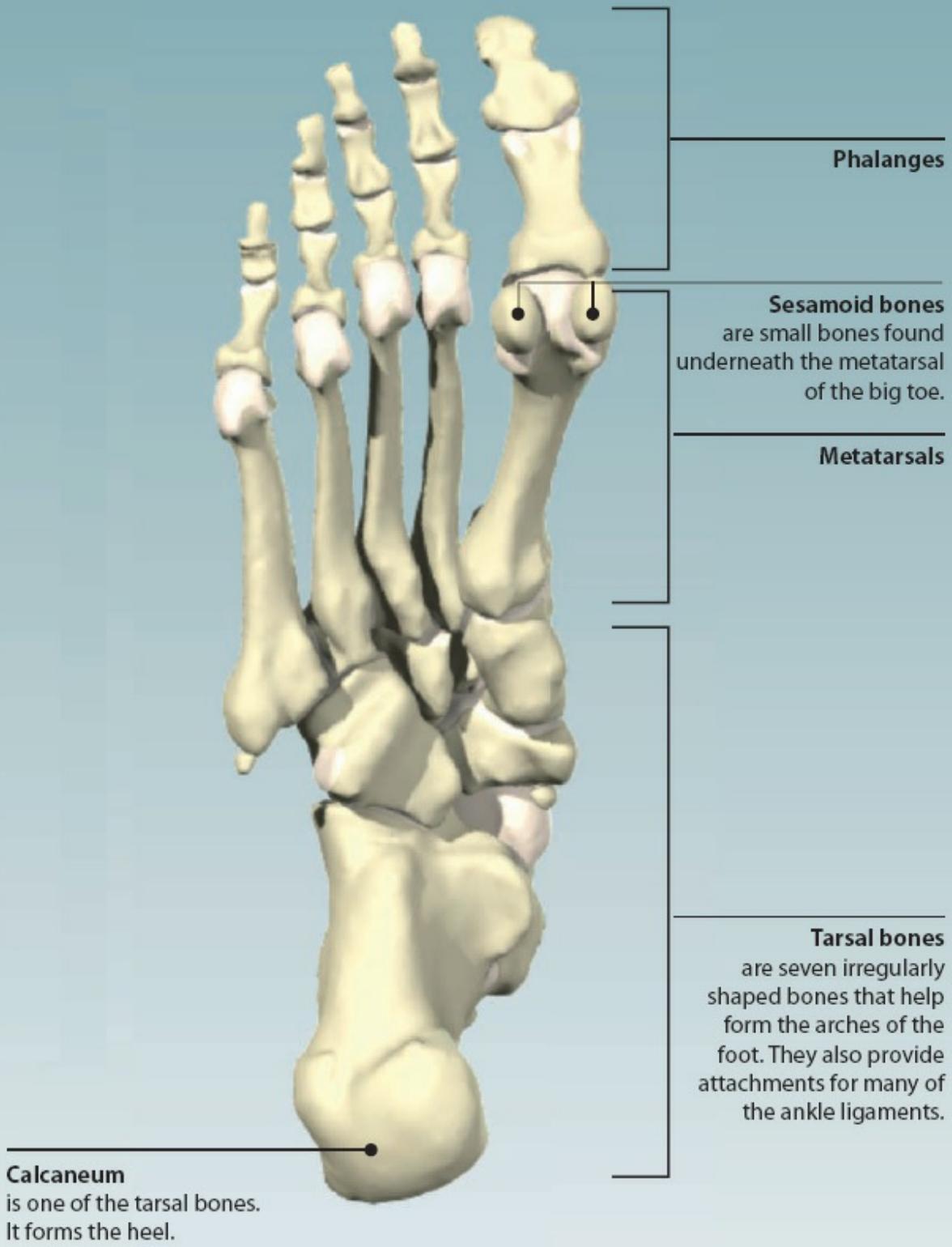
The foot contains twenty-six bones in total. These bones form arches, which help spread some of the forces as we walk.



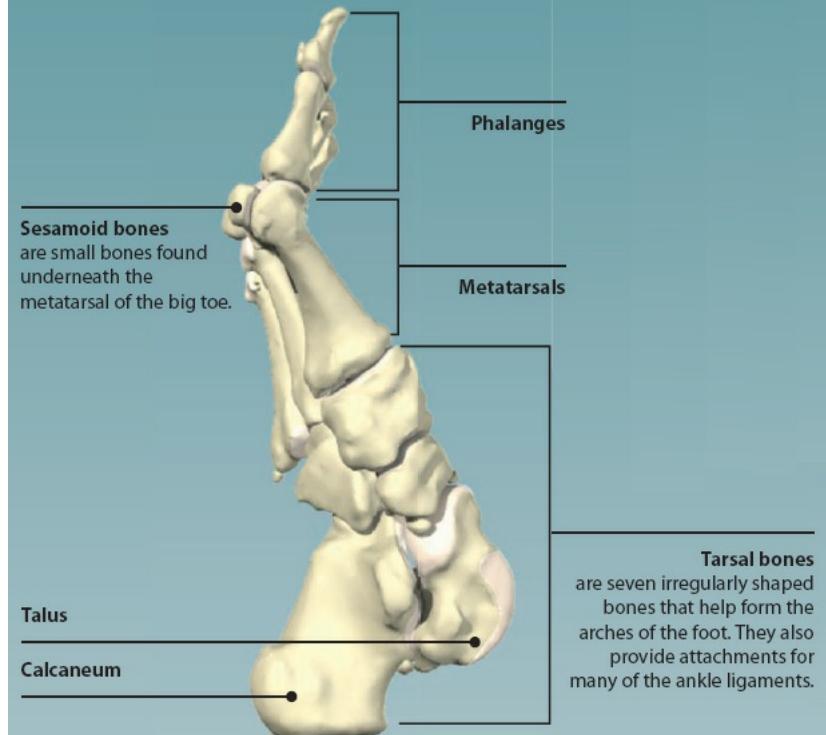
Bones of the Foot: Dorsal Aspect



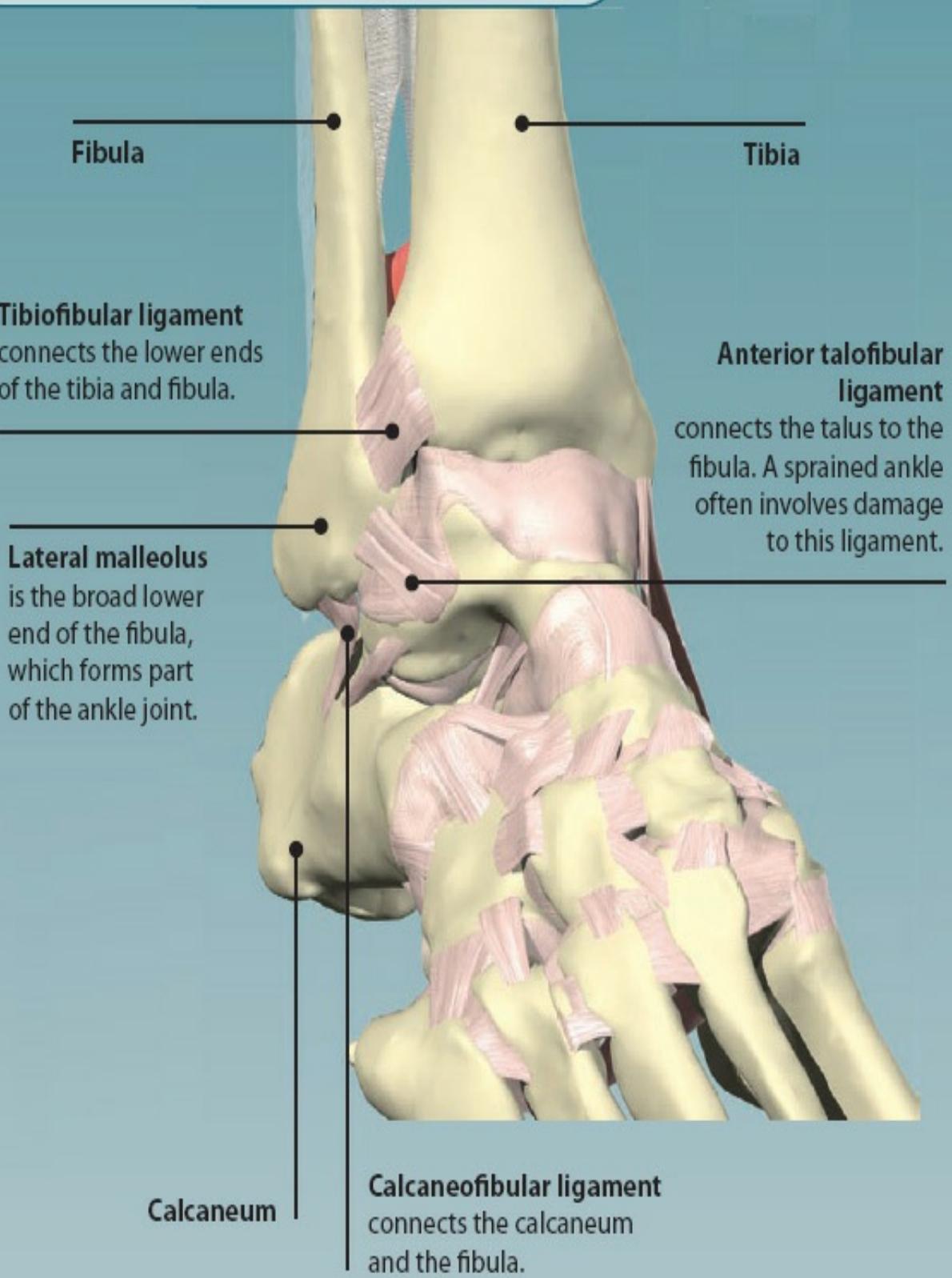
Bones of the Foot: Plantar Aspect

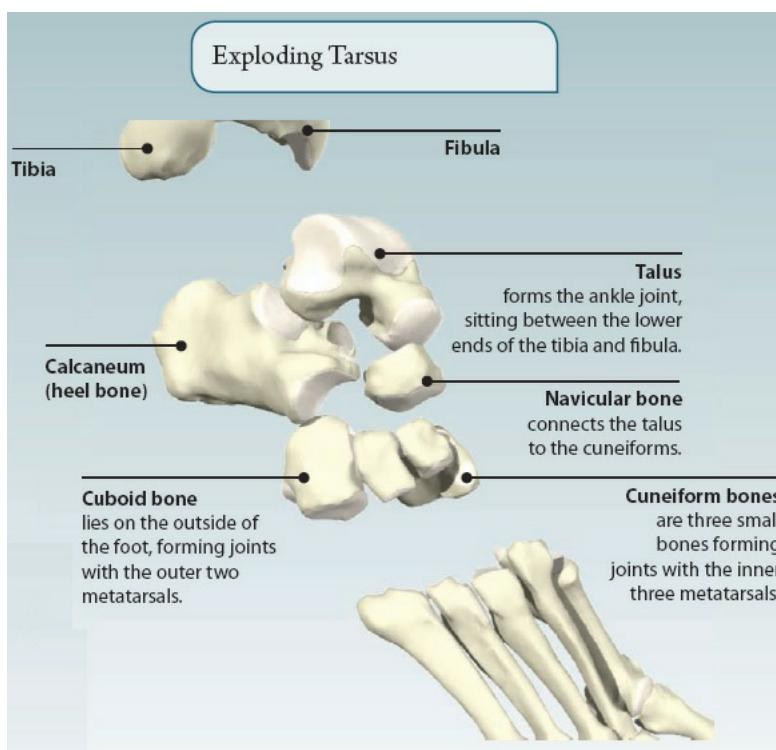
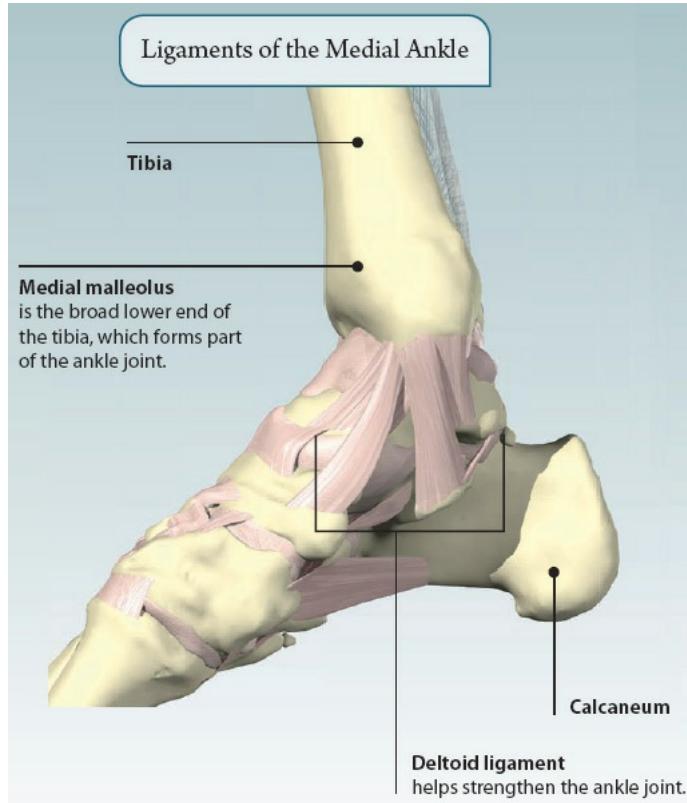


Bones of the Foot: Medial Aspect



Ligaments of the Ankle



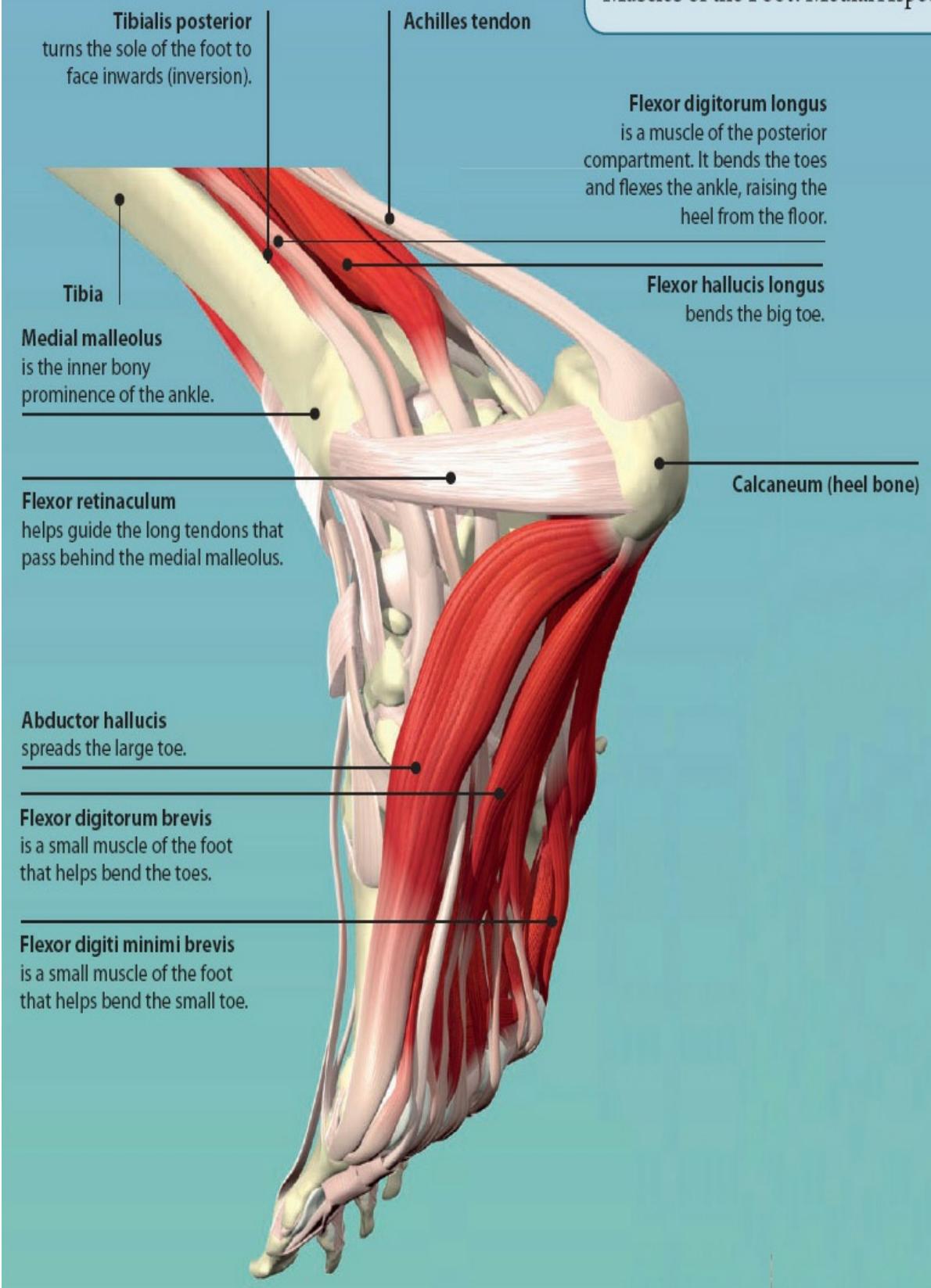


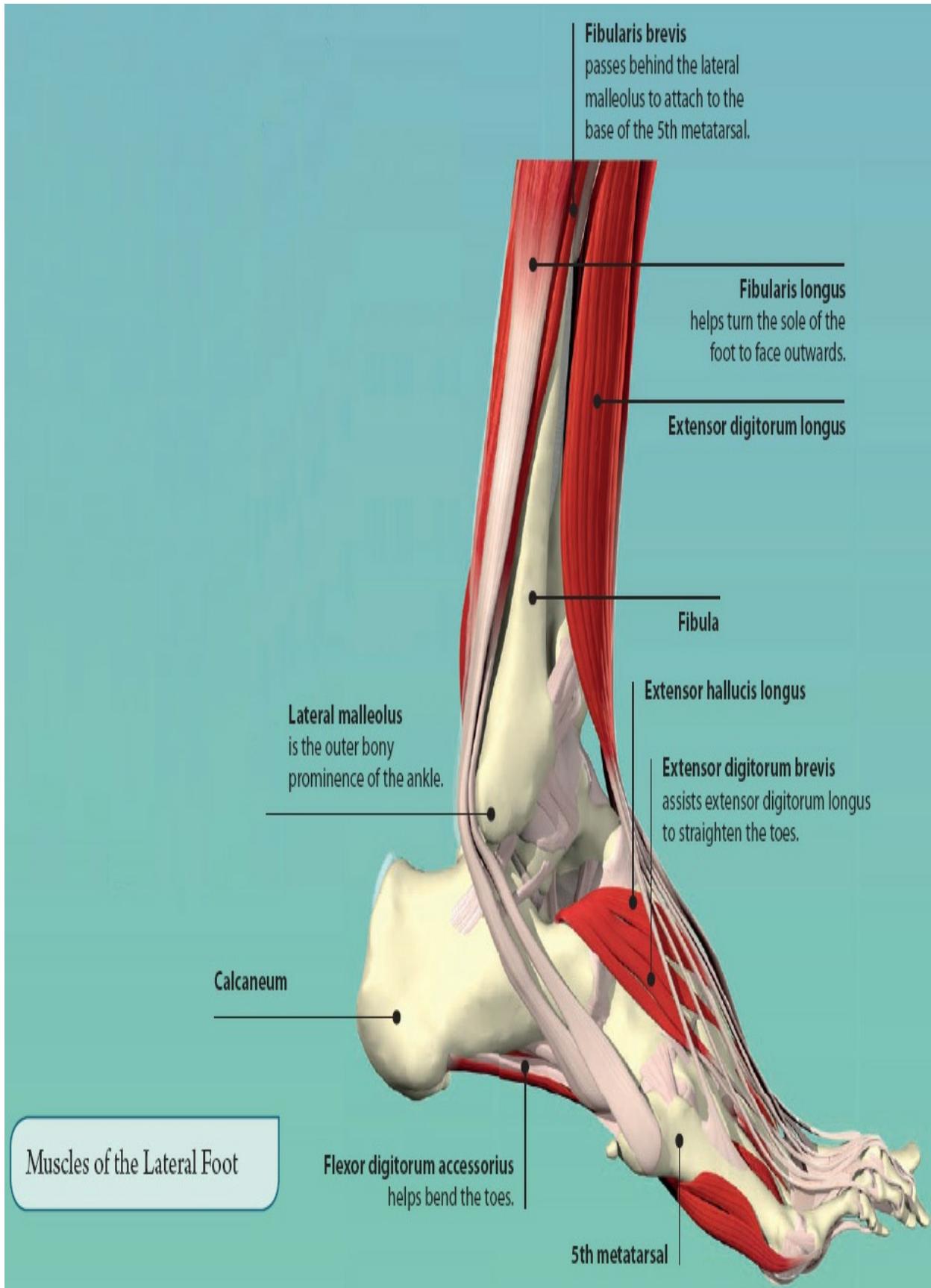
MUSCLES OF THE FOOT AND ANKLE

Muscles of the leg move both the ankle and the toes. They are helped in moving the toes by the muscles of the foot.

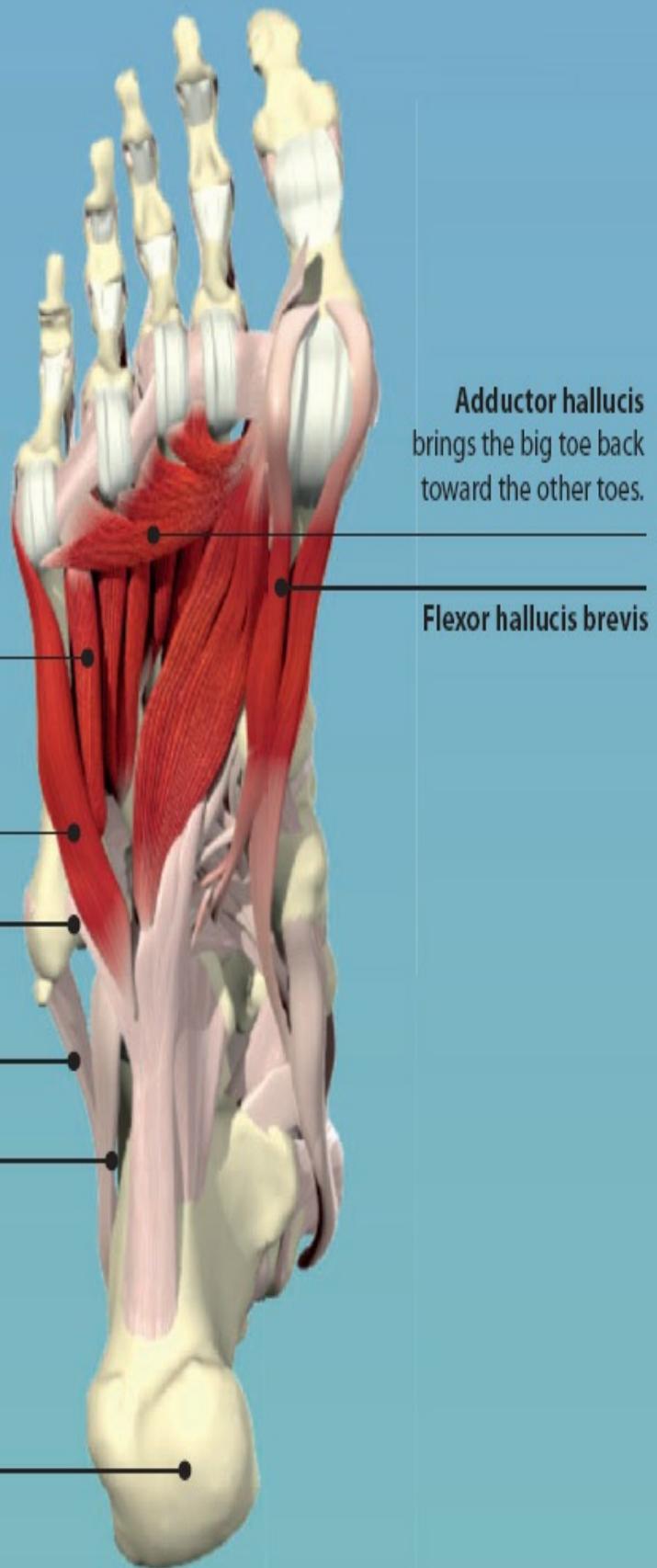
These small muscles are divided into two main groups: those on the top of the foot (dorsum) and those on the sole of the foot (plantar).

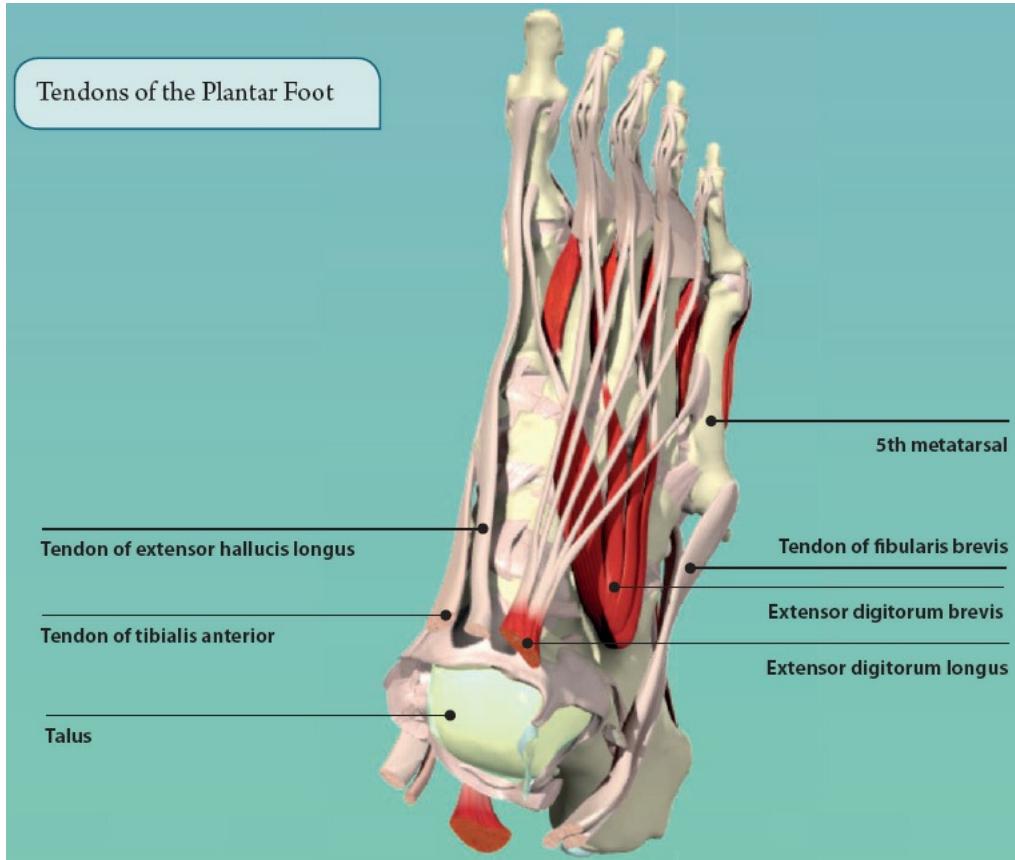
Muscles of the Foot: Medial Aspect





Deep Muscles of the Sole

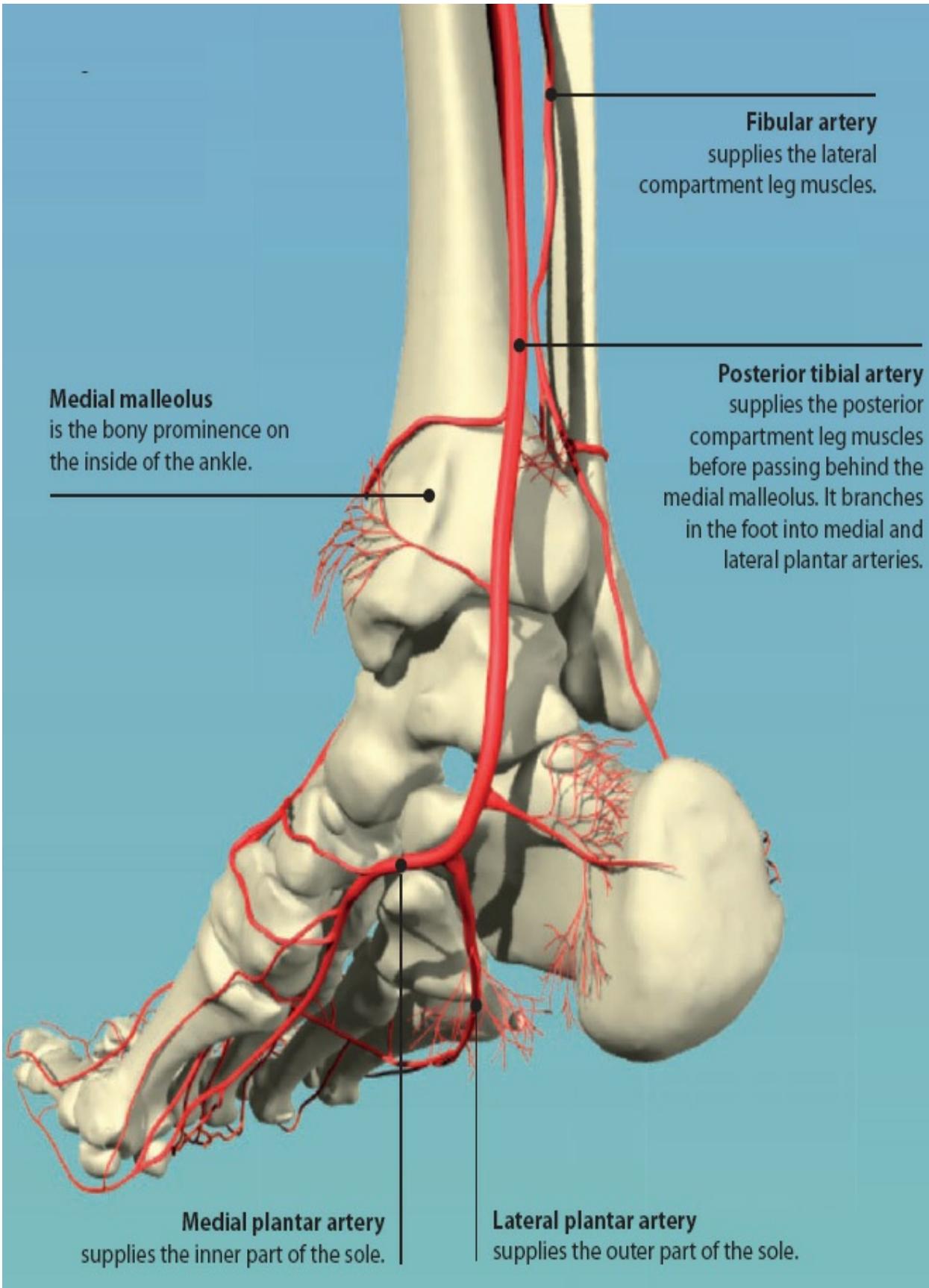




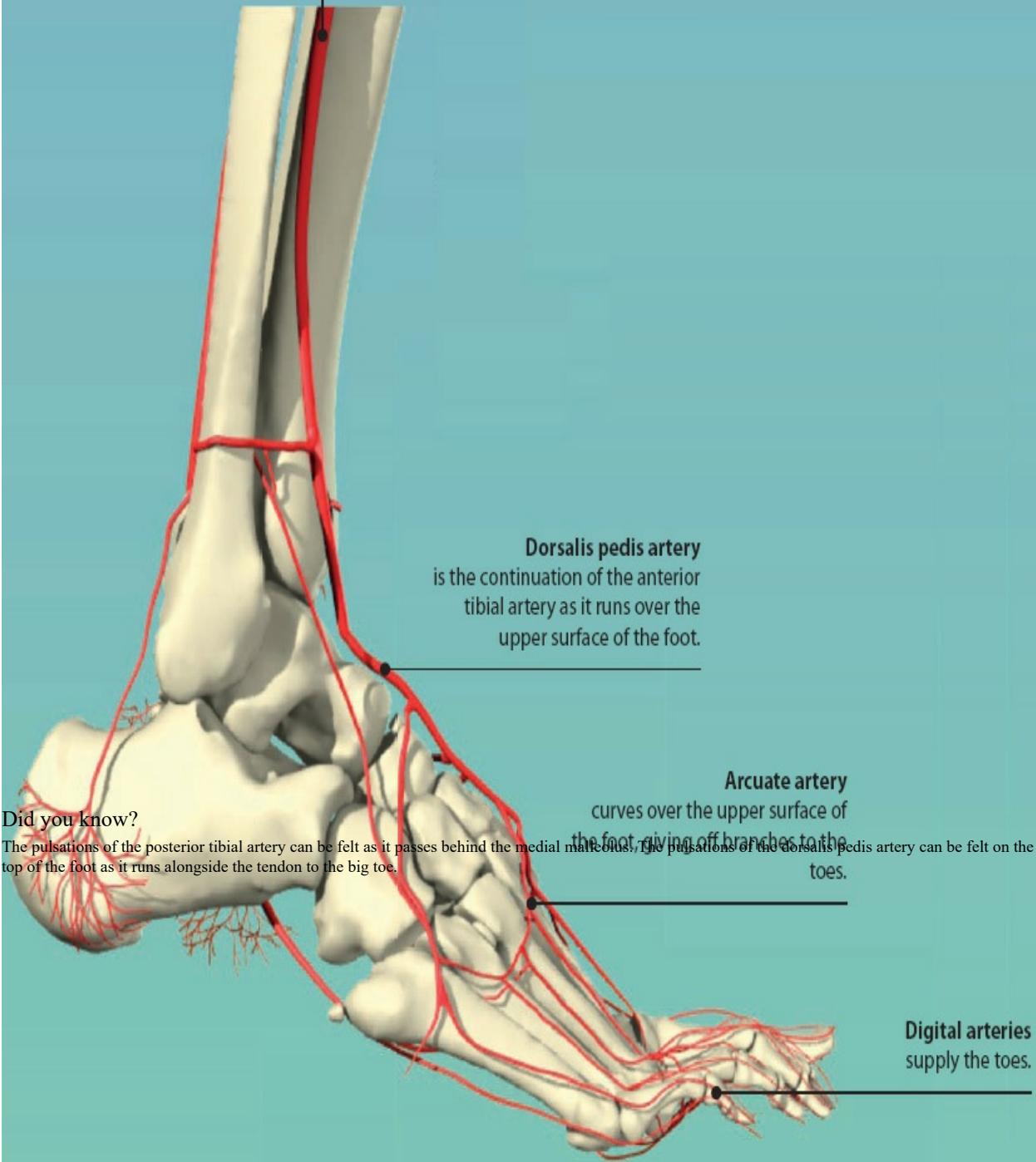


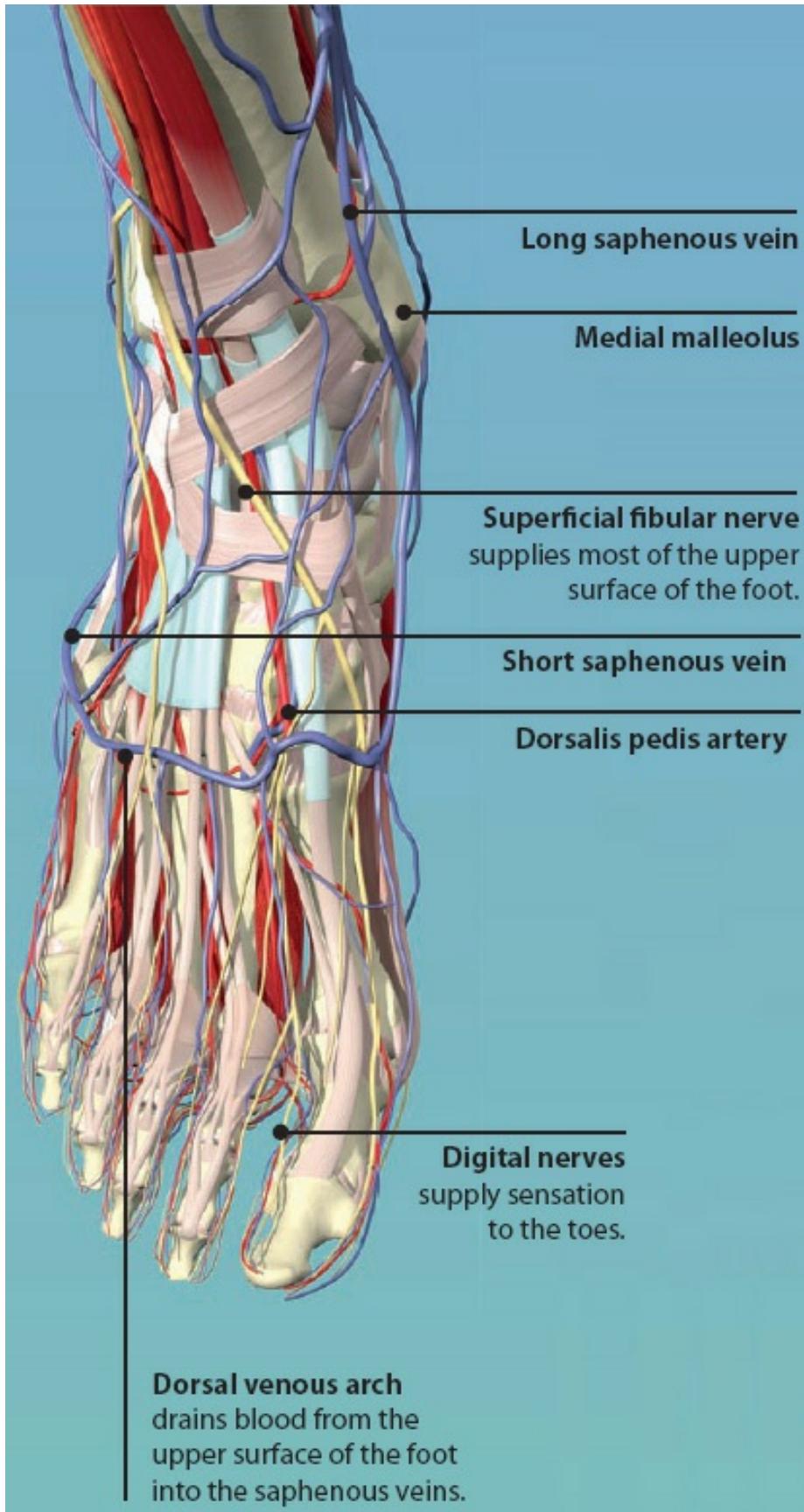
NEUROVASCULAR STRUCTURES OF THE FOOT AND ANKLE

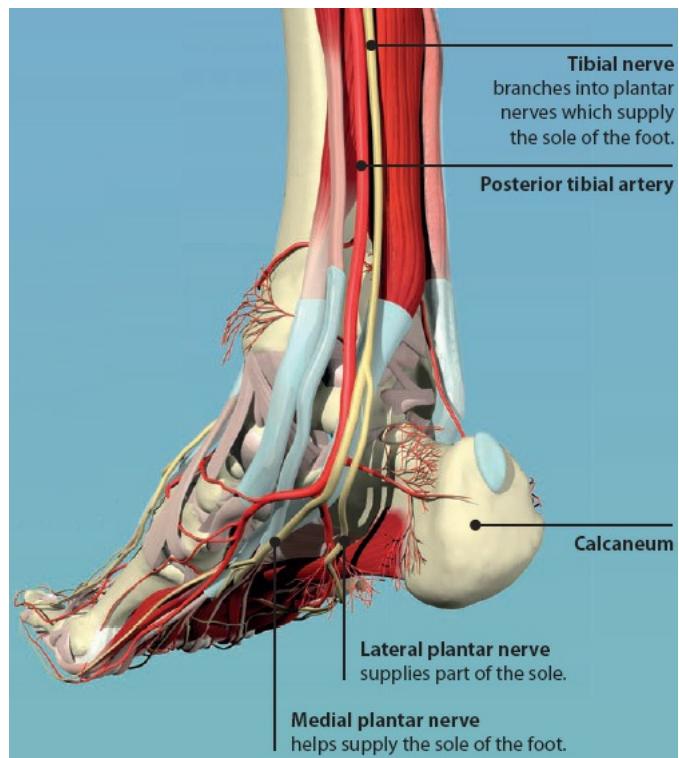
Arteries and veins travel the length of the lower limb, carrying blood to and from the foot. Various nerves supply sensation to upper and lower surfaces of the foot.

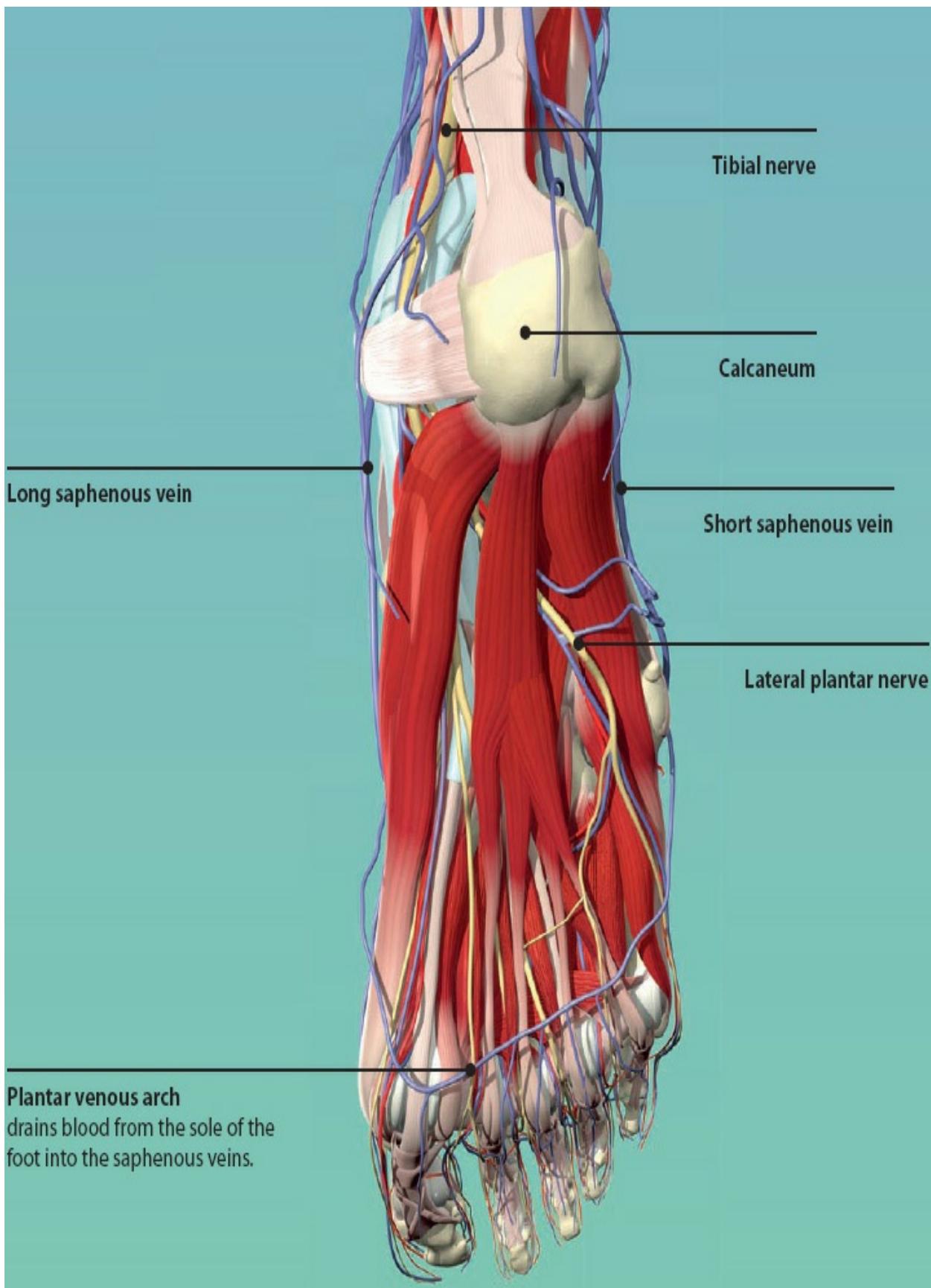


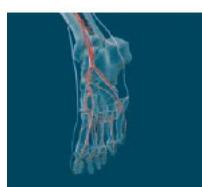
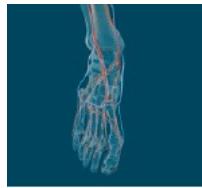
Anterior tibial artery
is a branch of the popliteal artery. It supplies the anterior compartment leg muscles, before continuing into the foot.





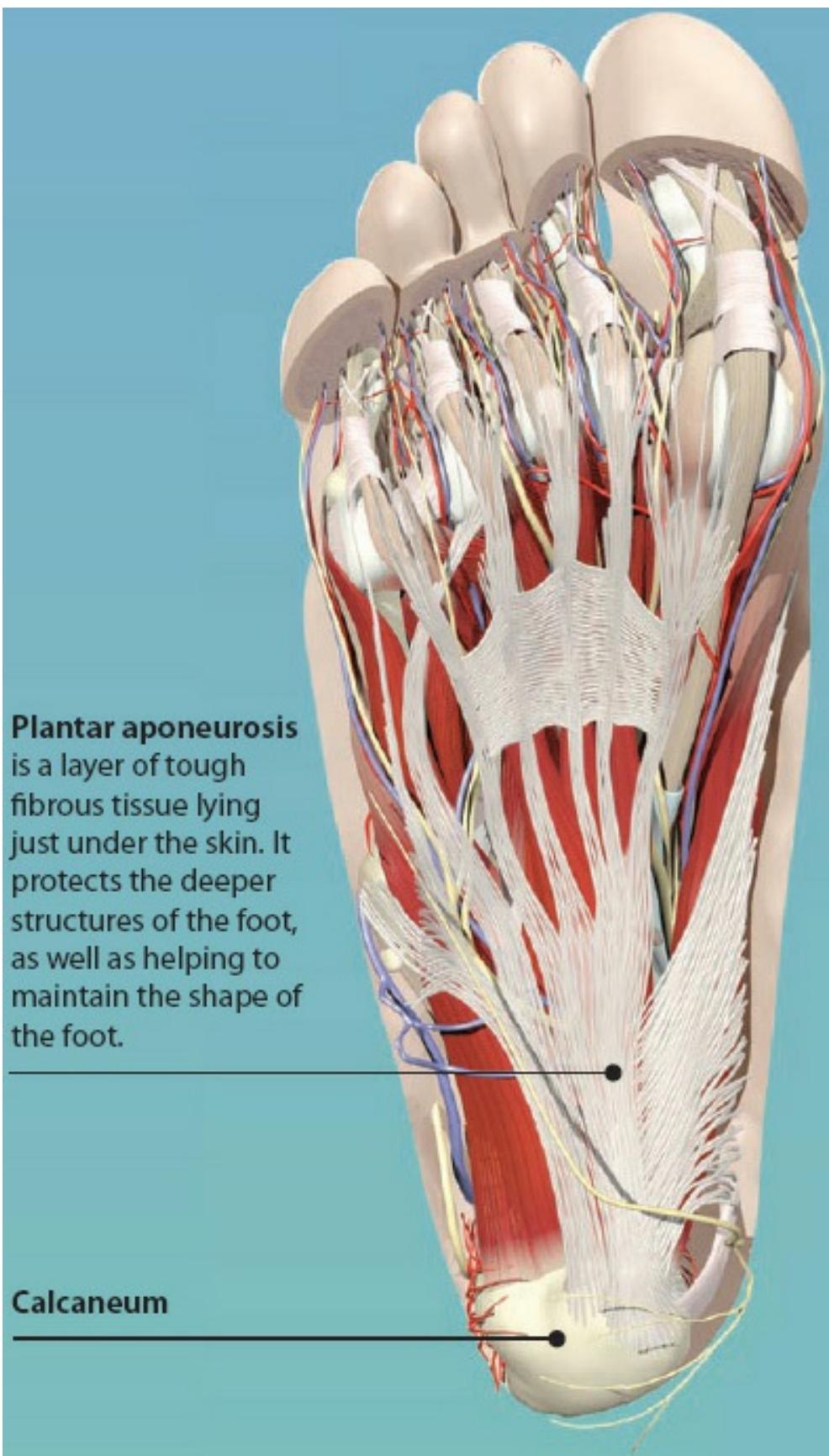






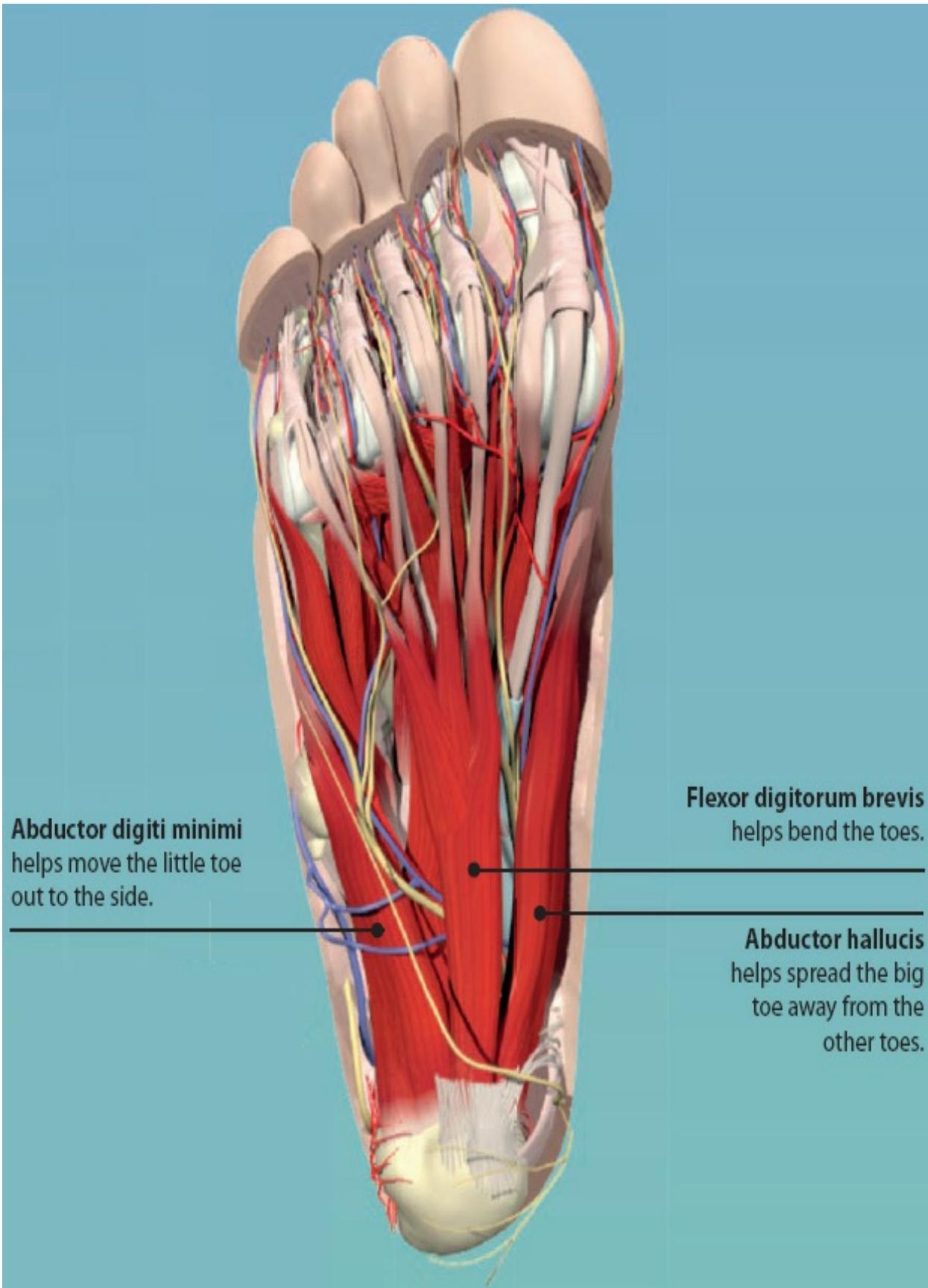
PLANTAR DISSECTION

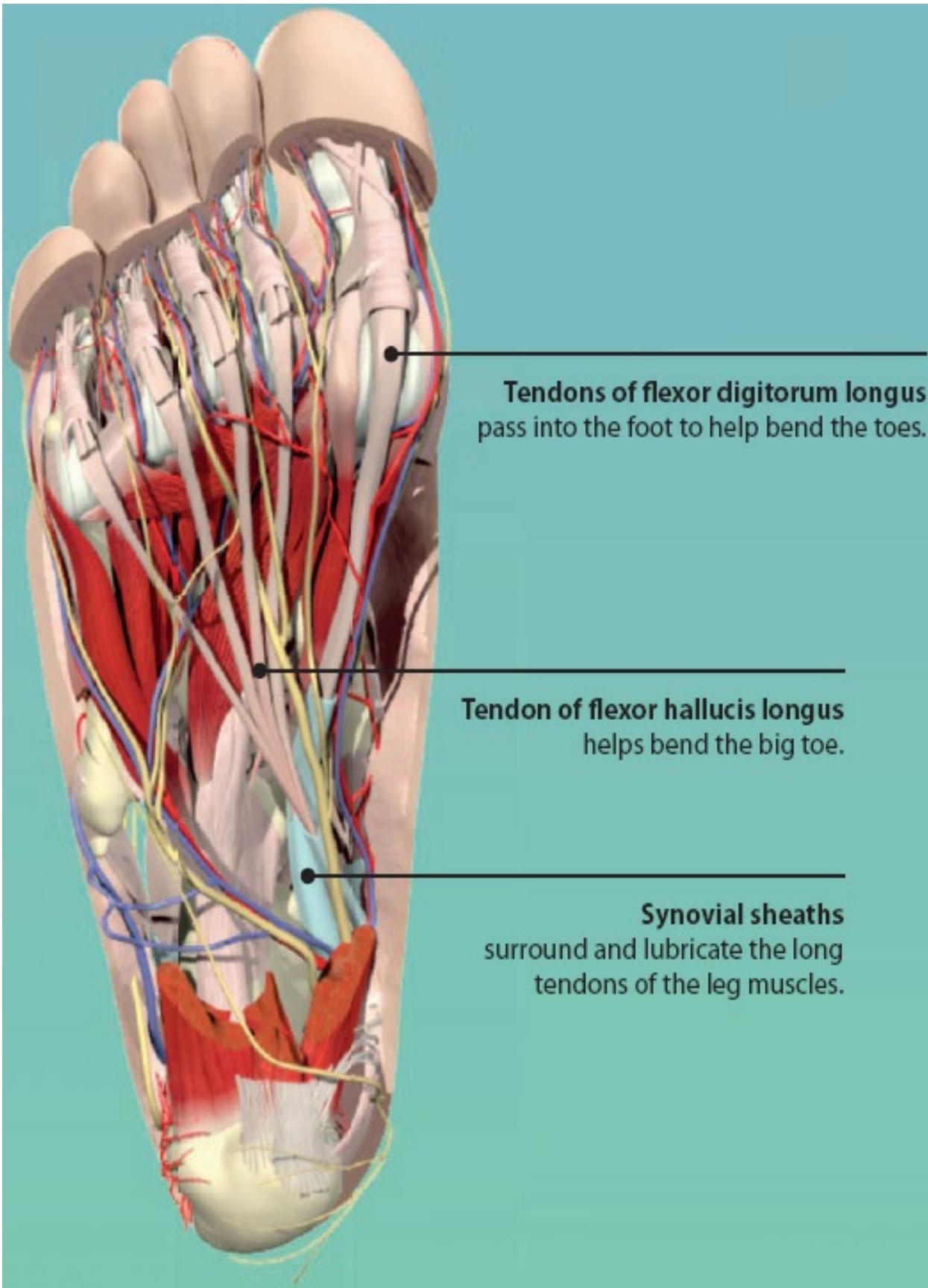
The sole of the foot (plantar surface) distributes the weight of the body as we walk. Most of the small muscles of the foot are found in the sole where they are arranged into different layers. In addition, many blood vessels, nerves, and other structures pass through this region.

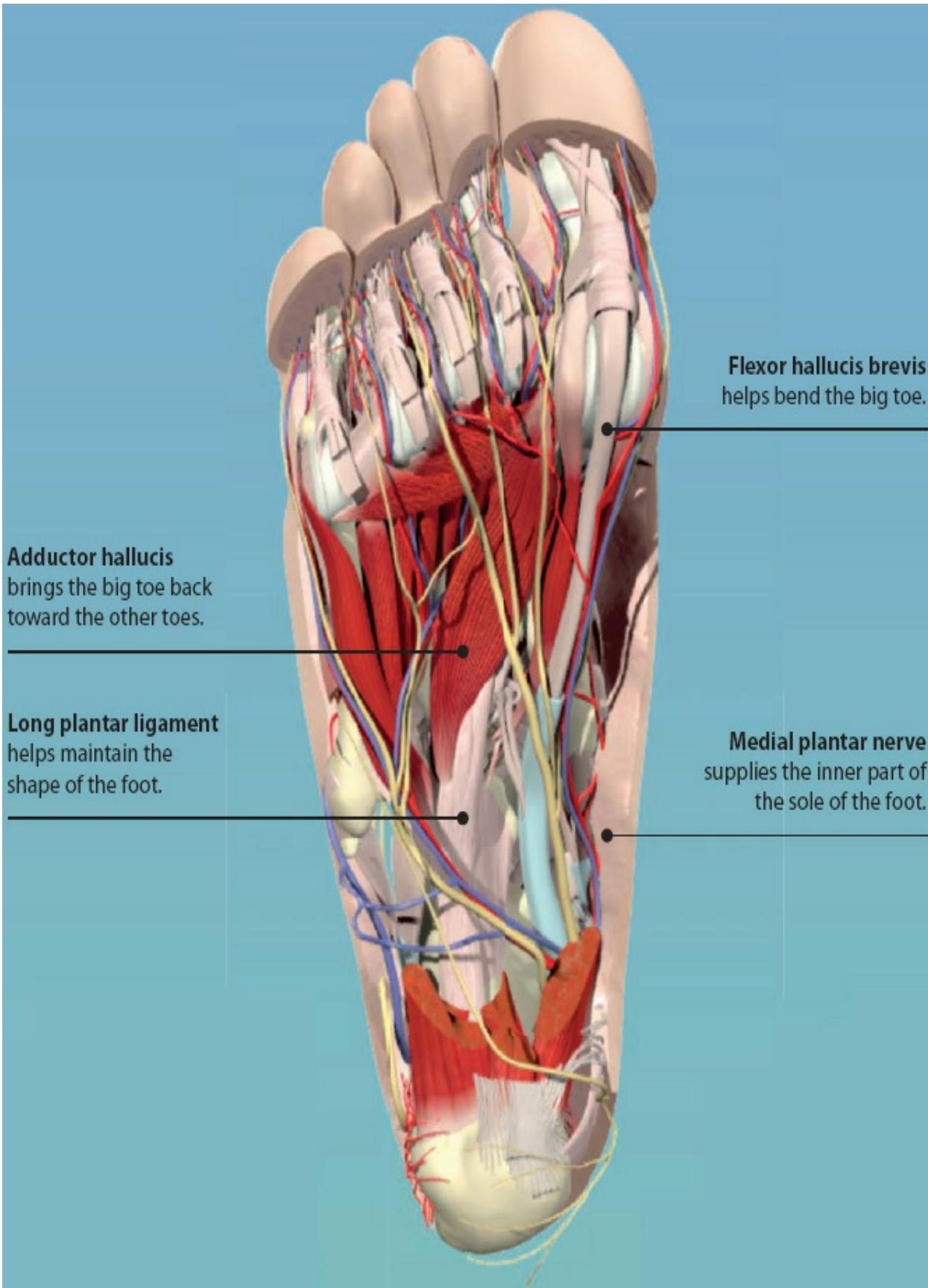


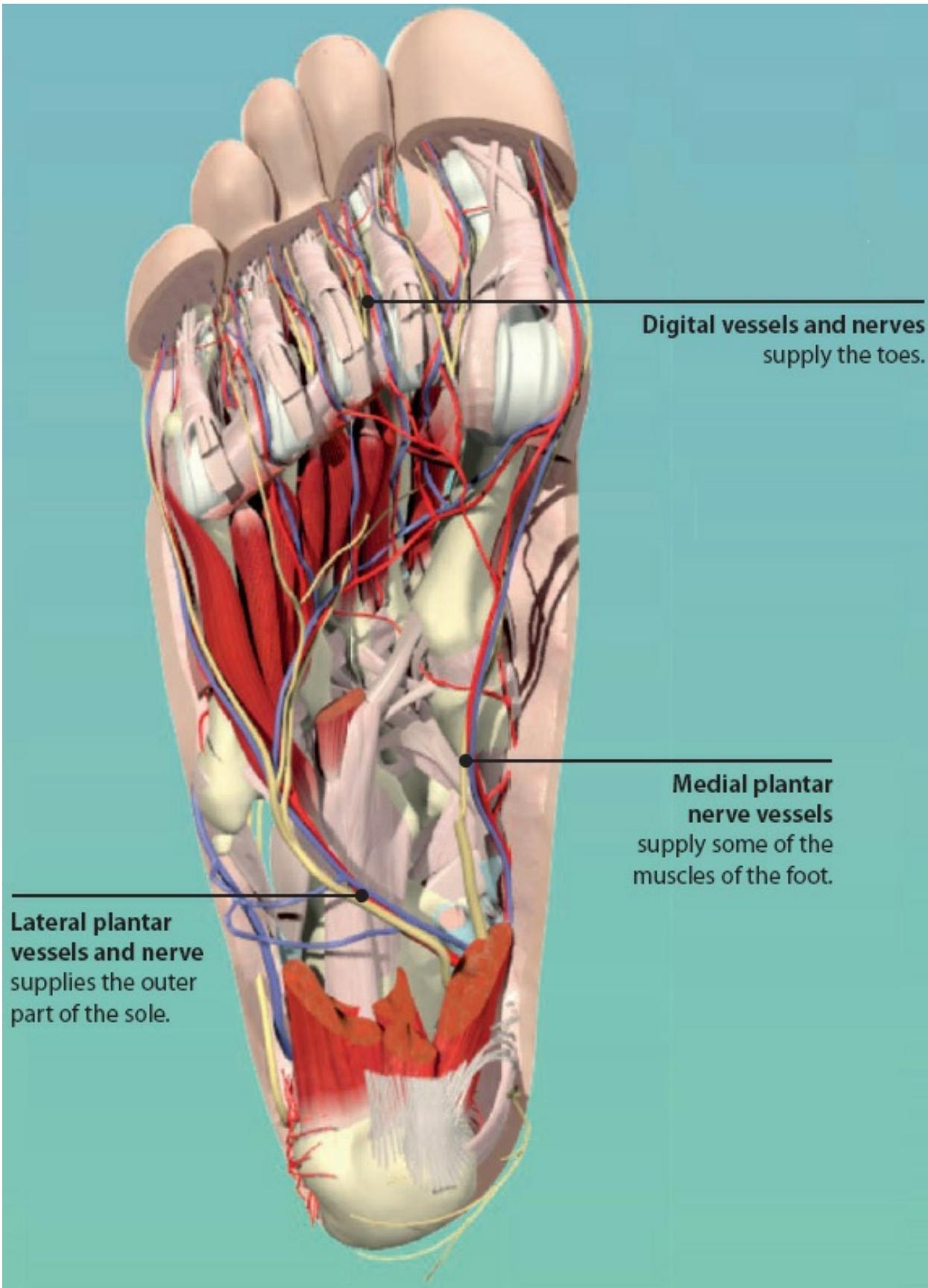
Plantar aponeurosis is a layer of tough fibrous tissue lying just under the skin. It protects the deeper structures of the foot, as well as helping to maintain the shape of the foot.

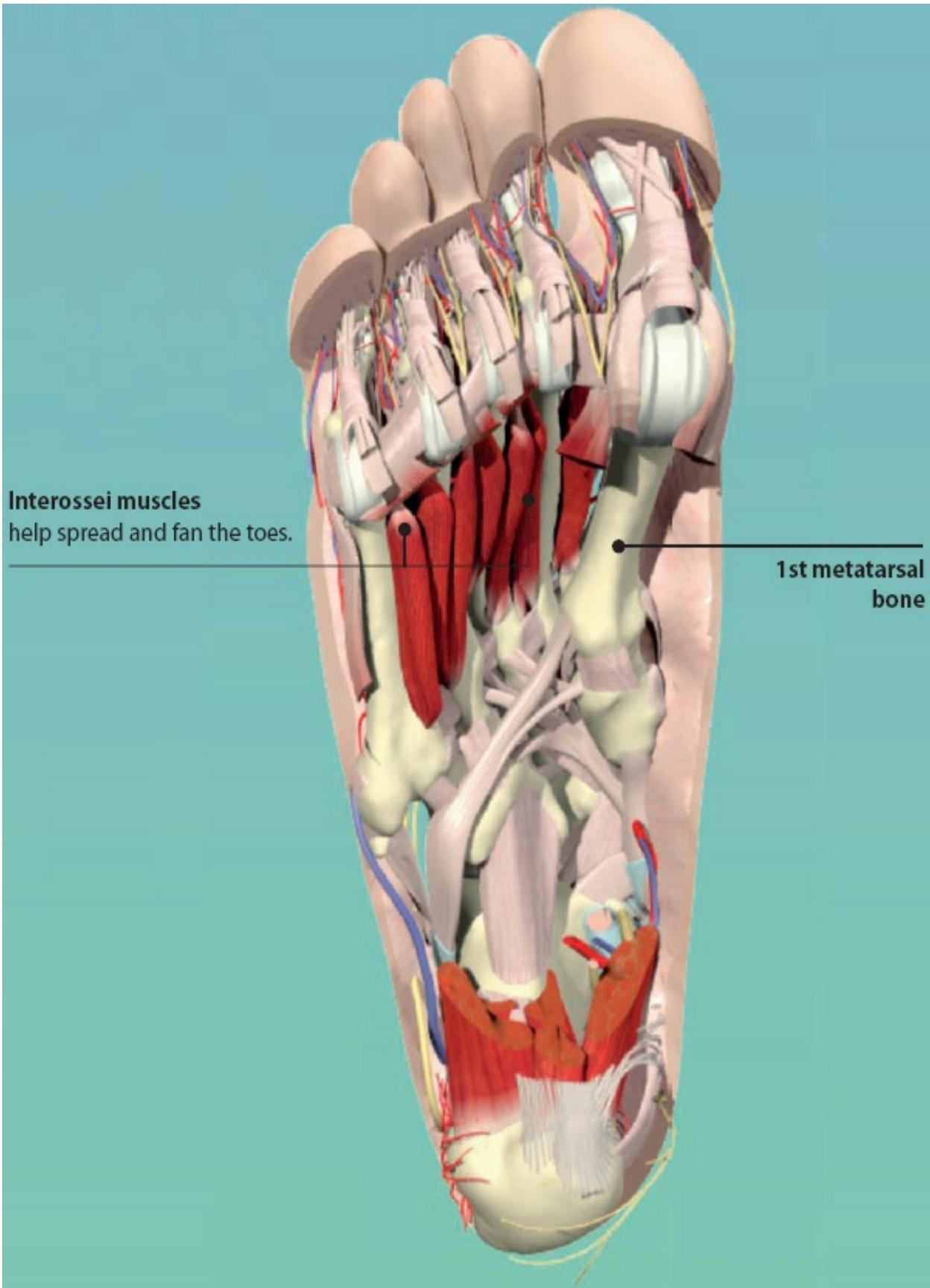
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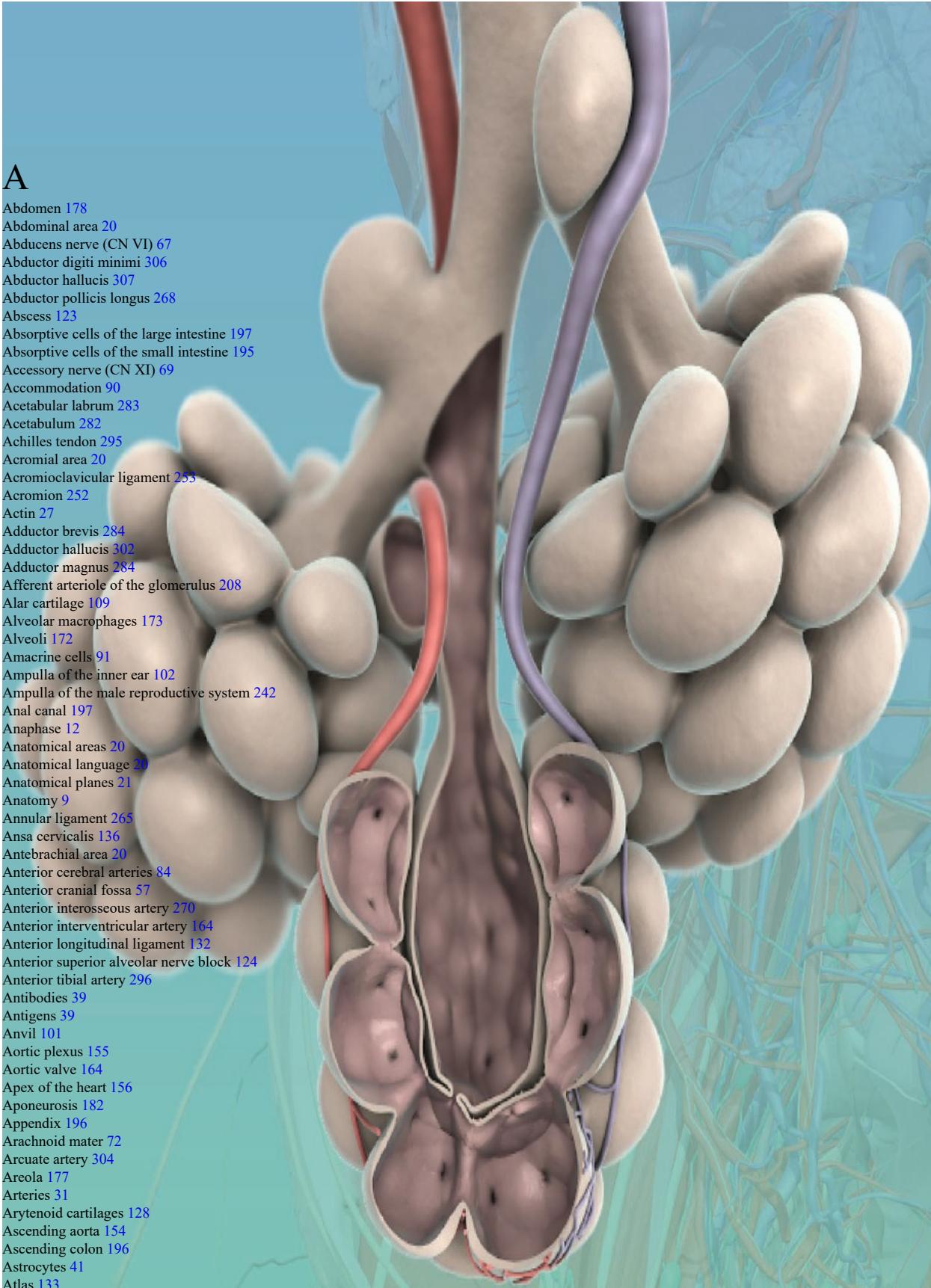








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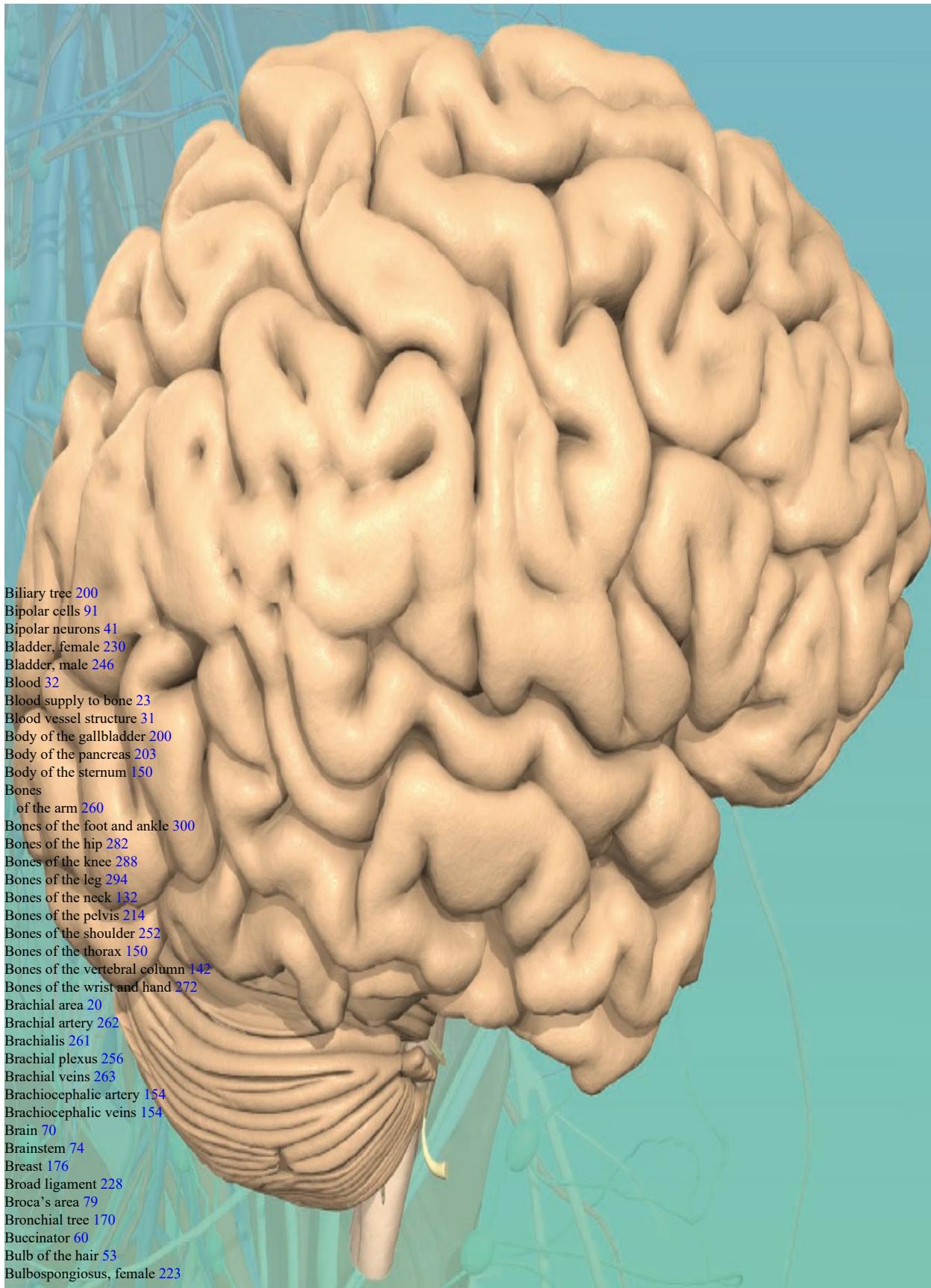
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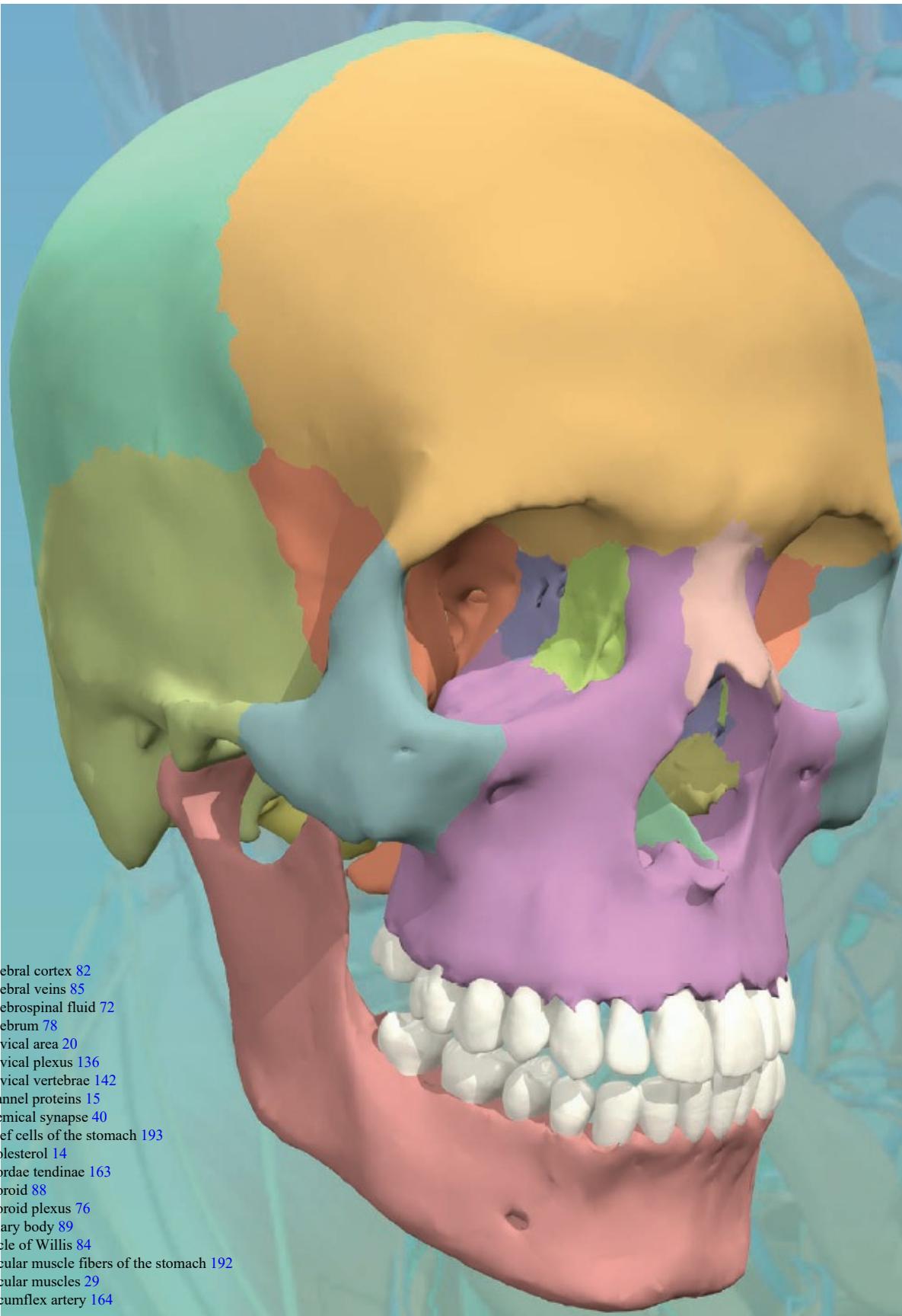
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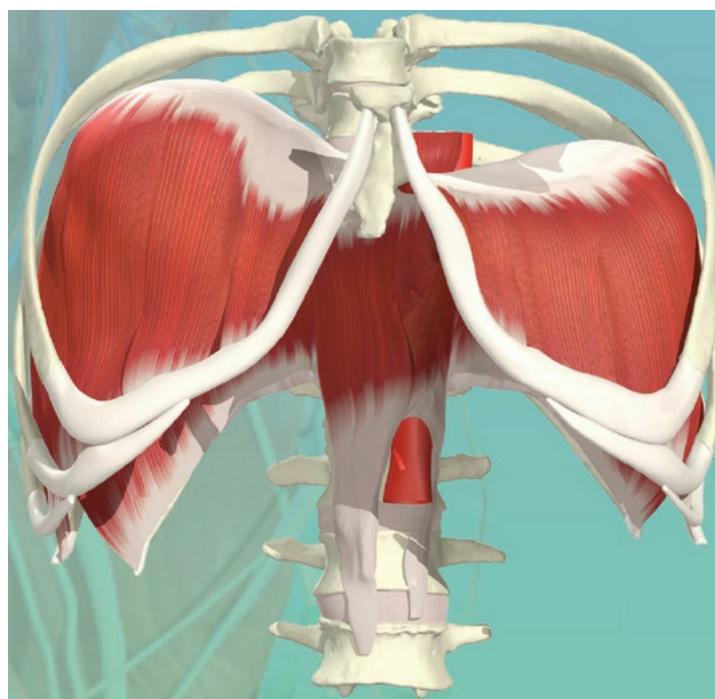
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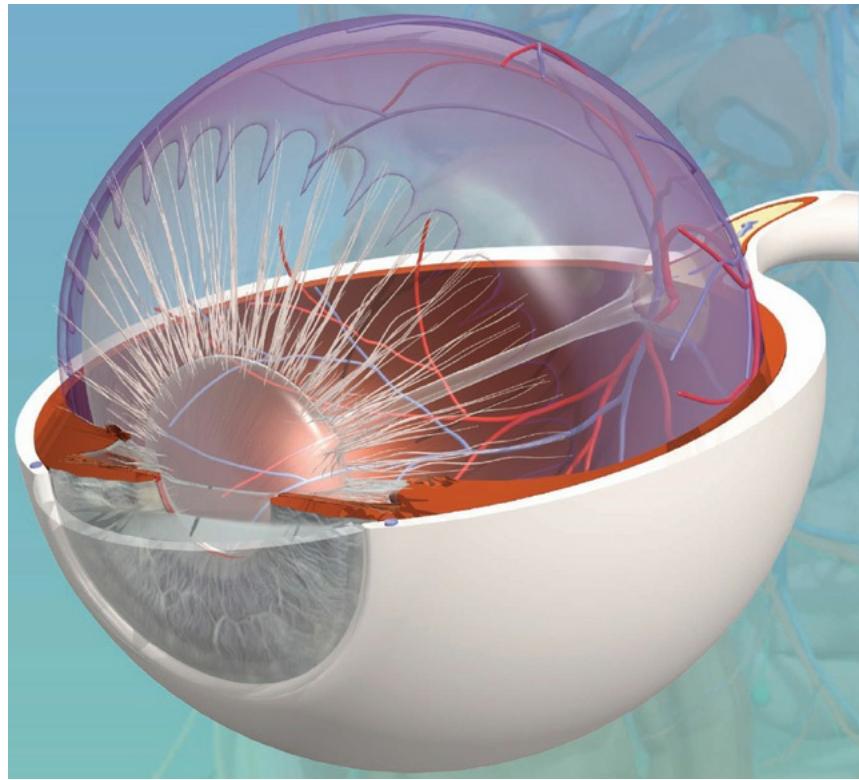
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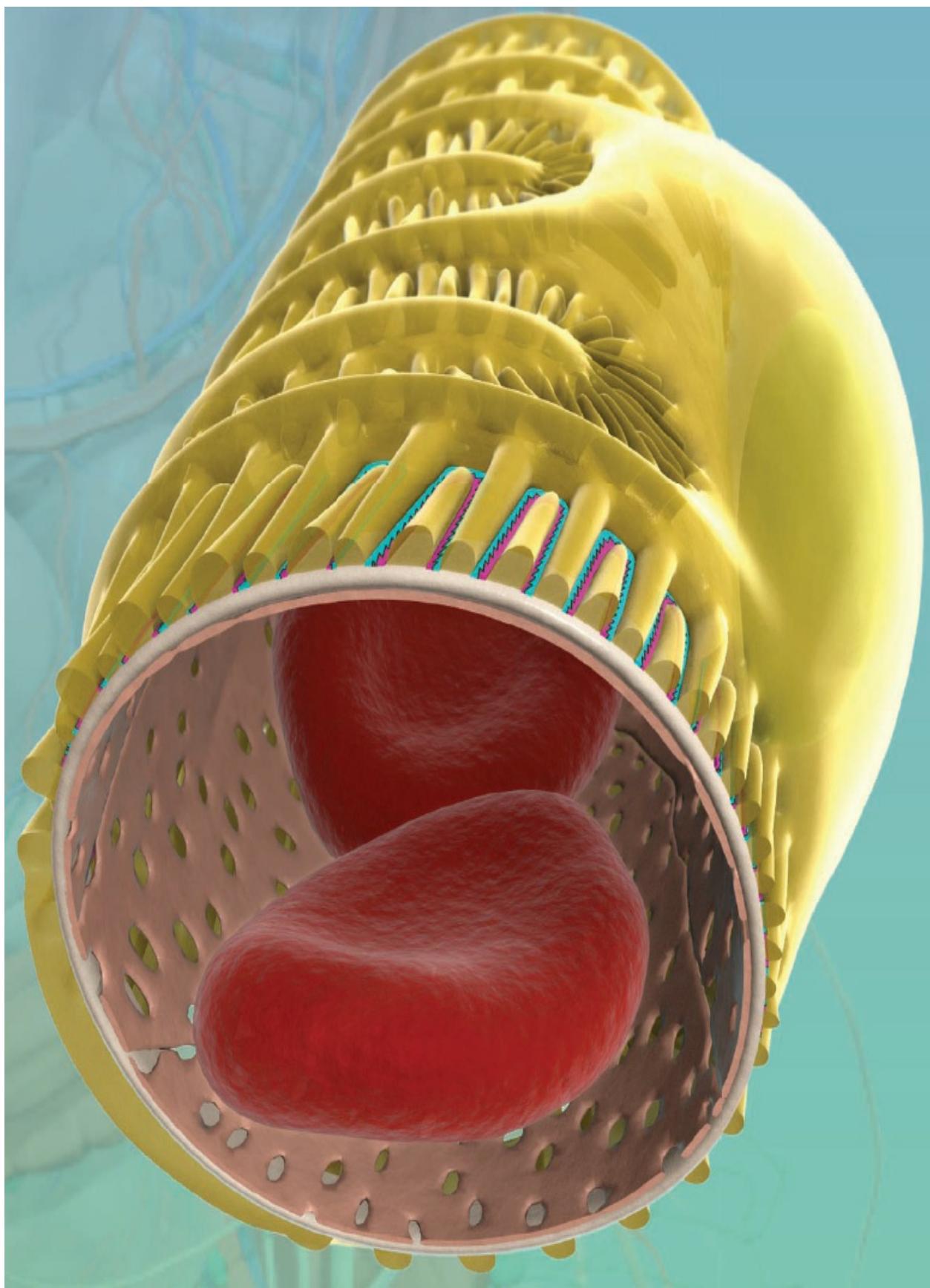
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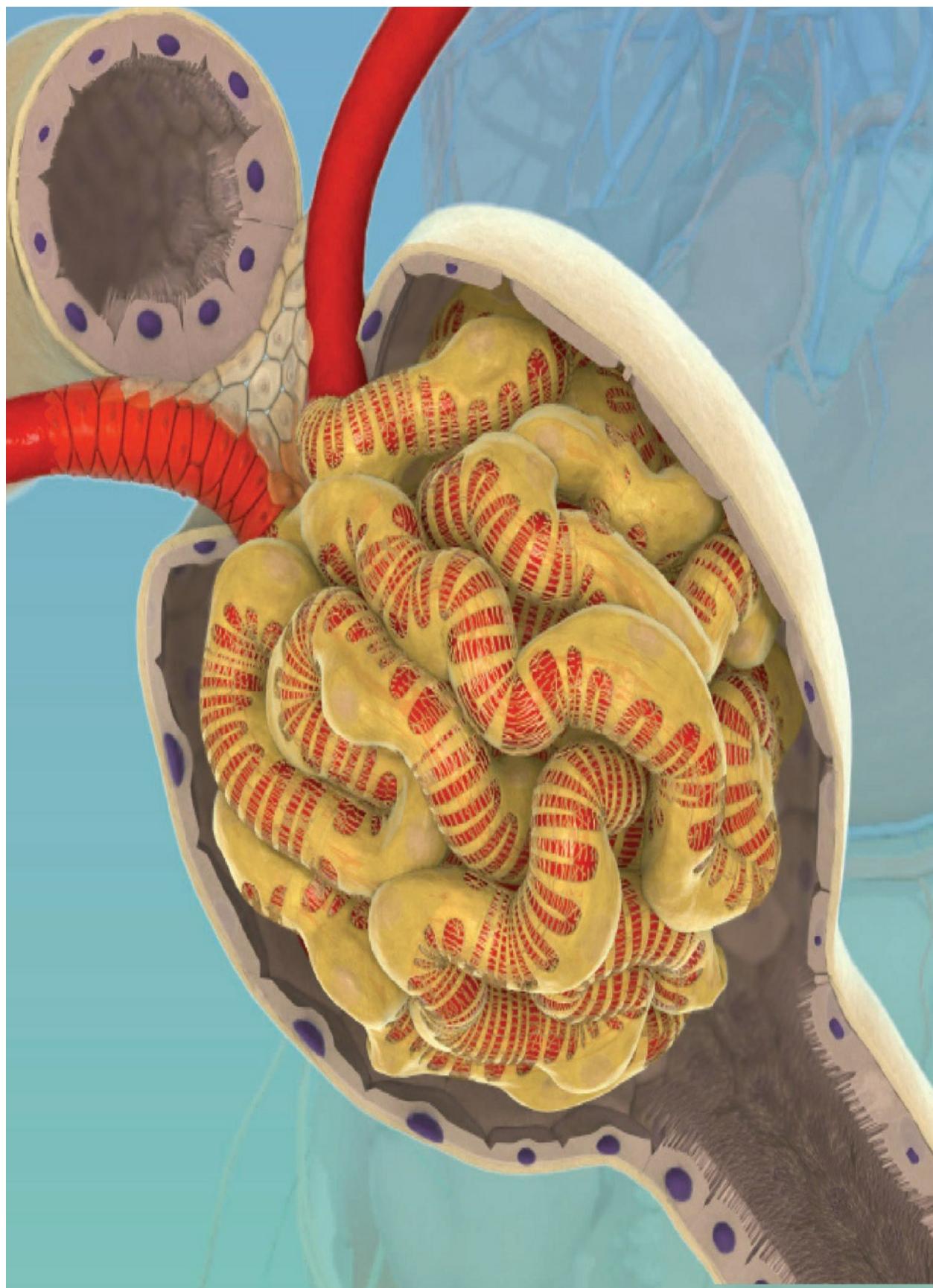
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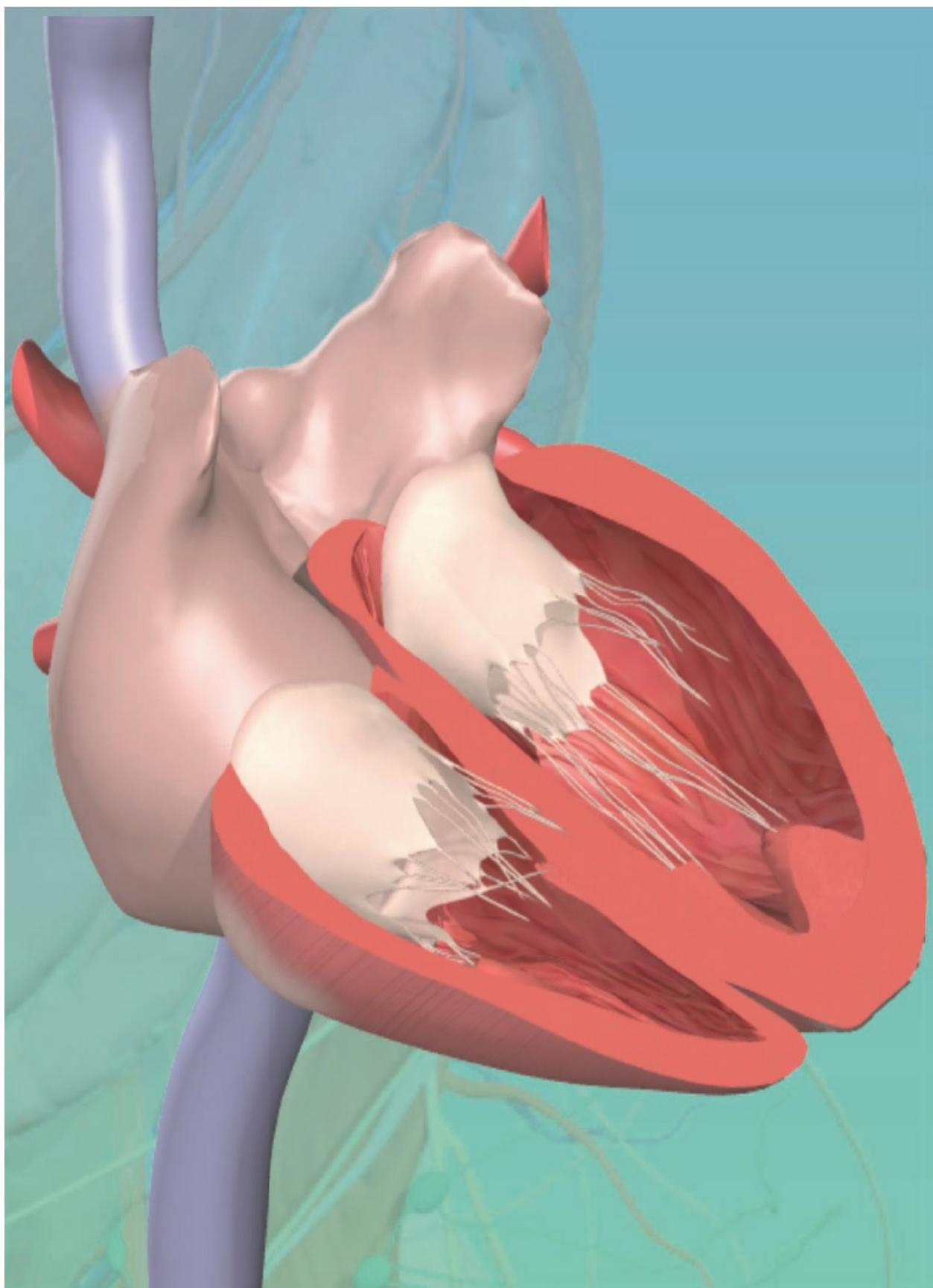
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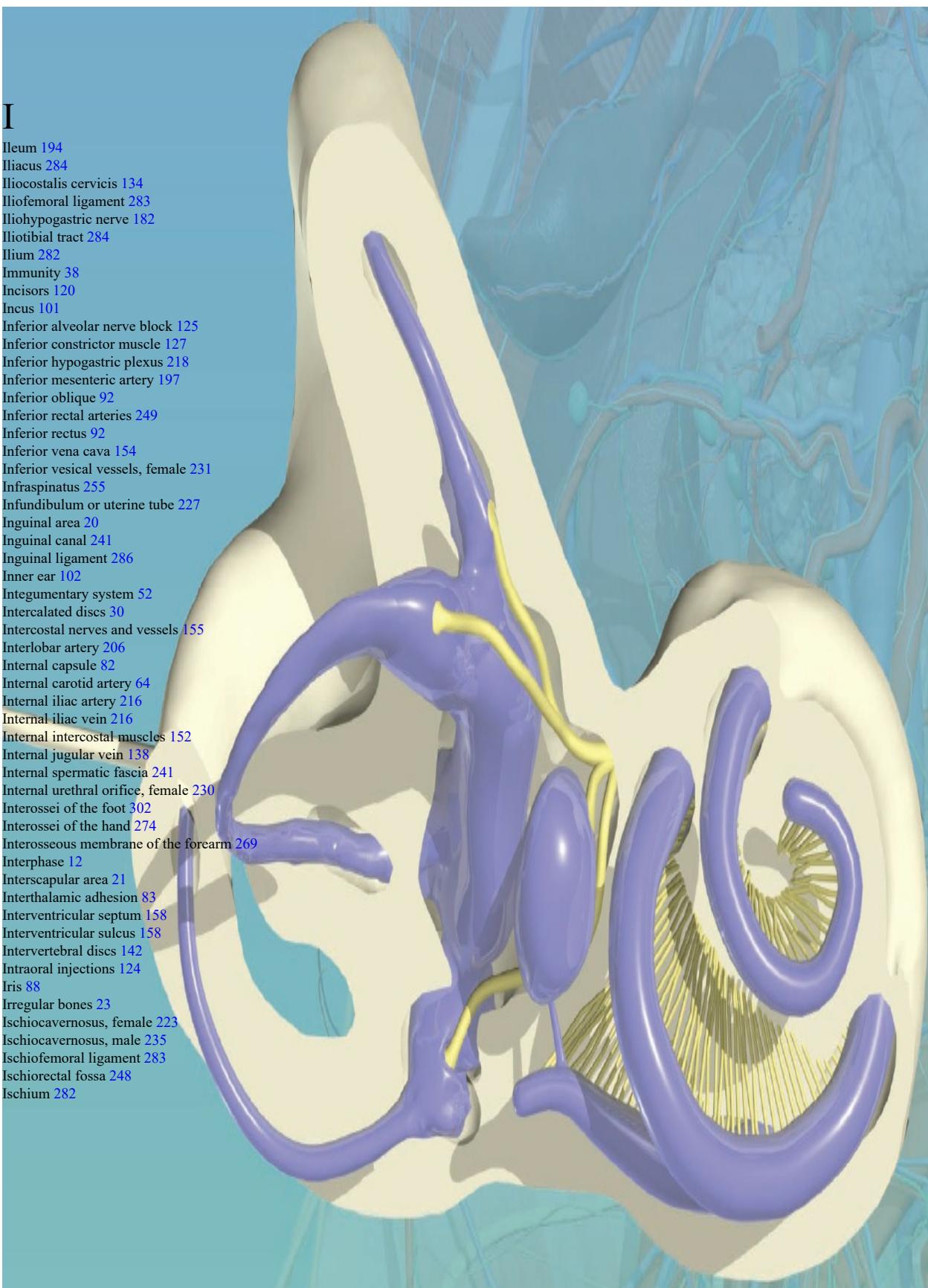
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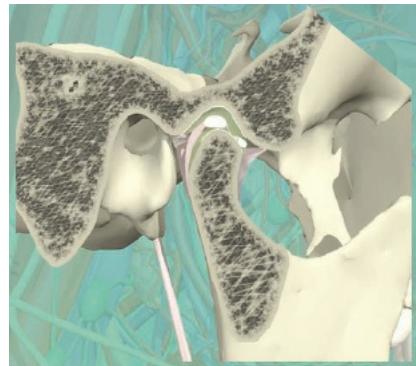
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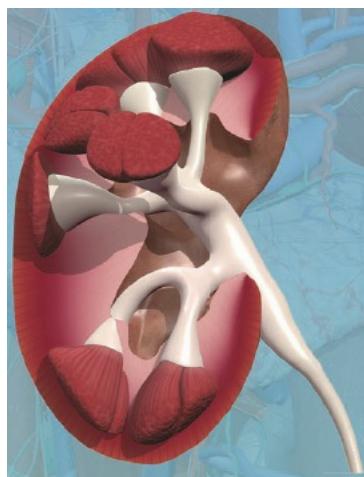






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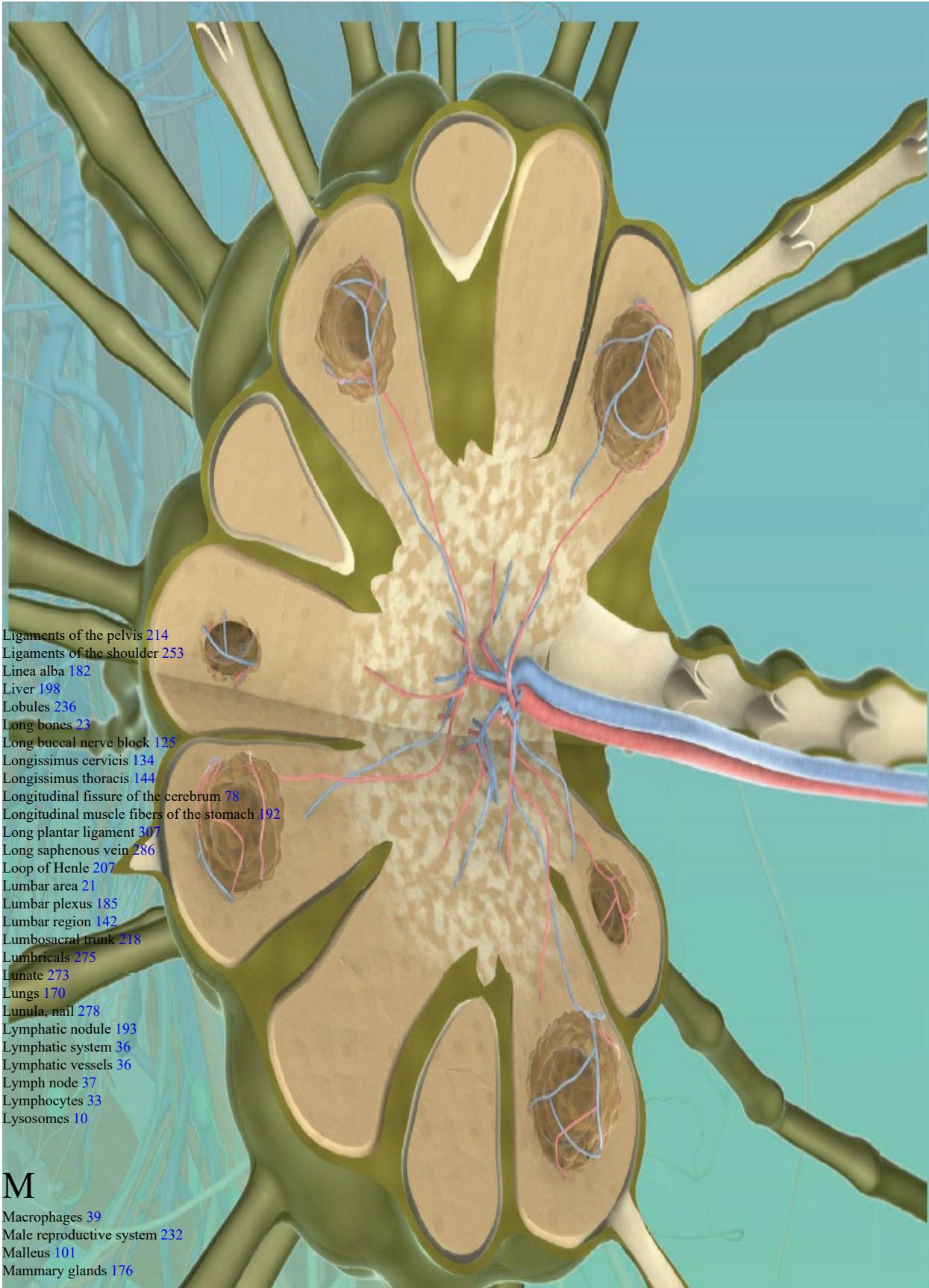
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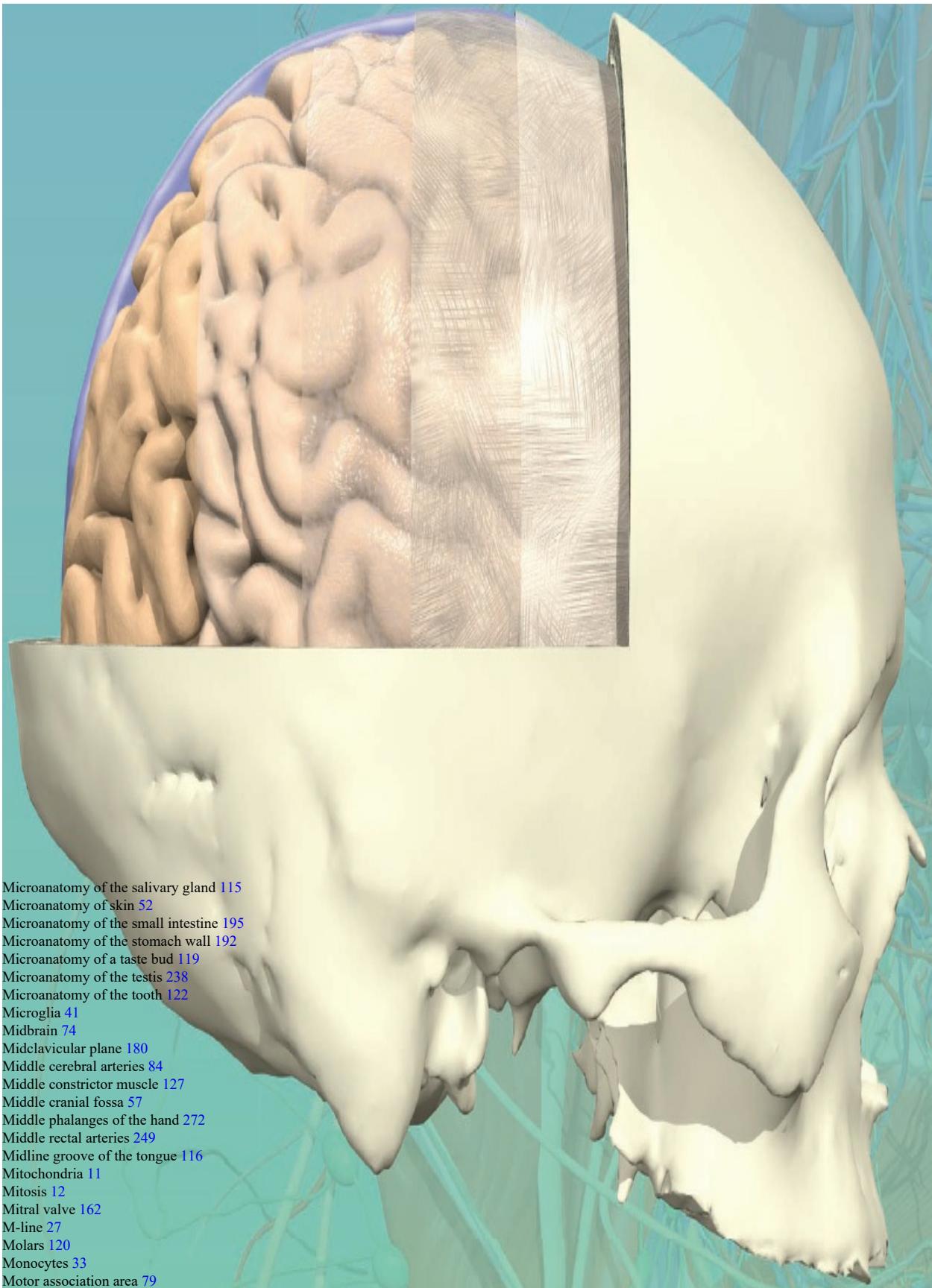
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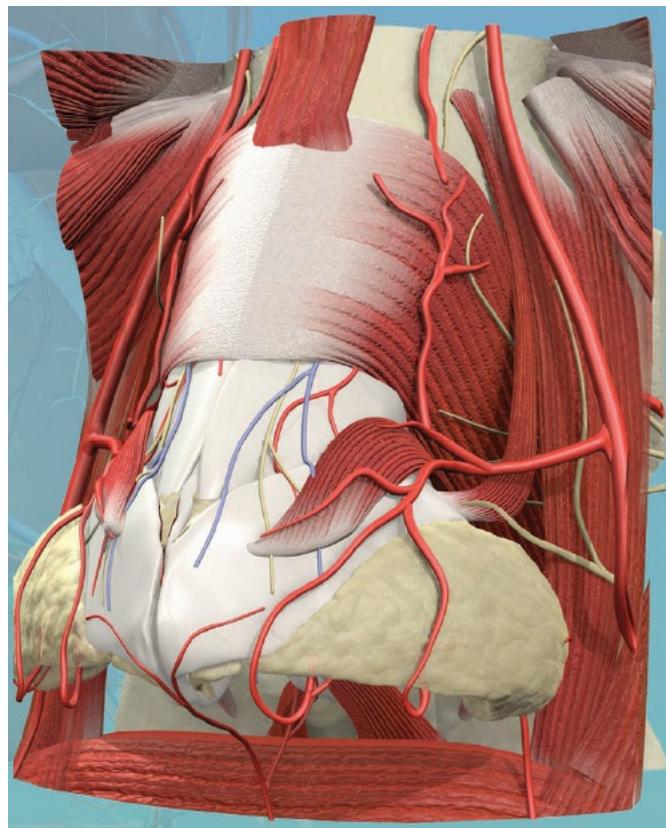
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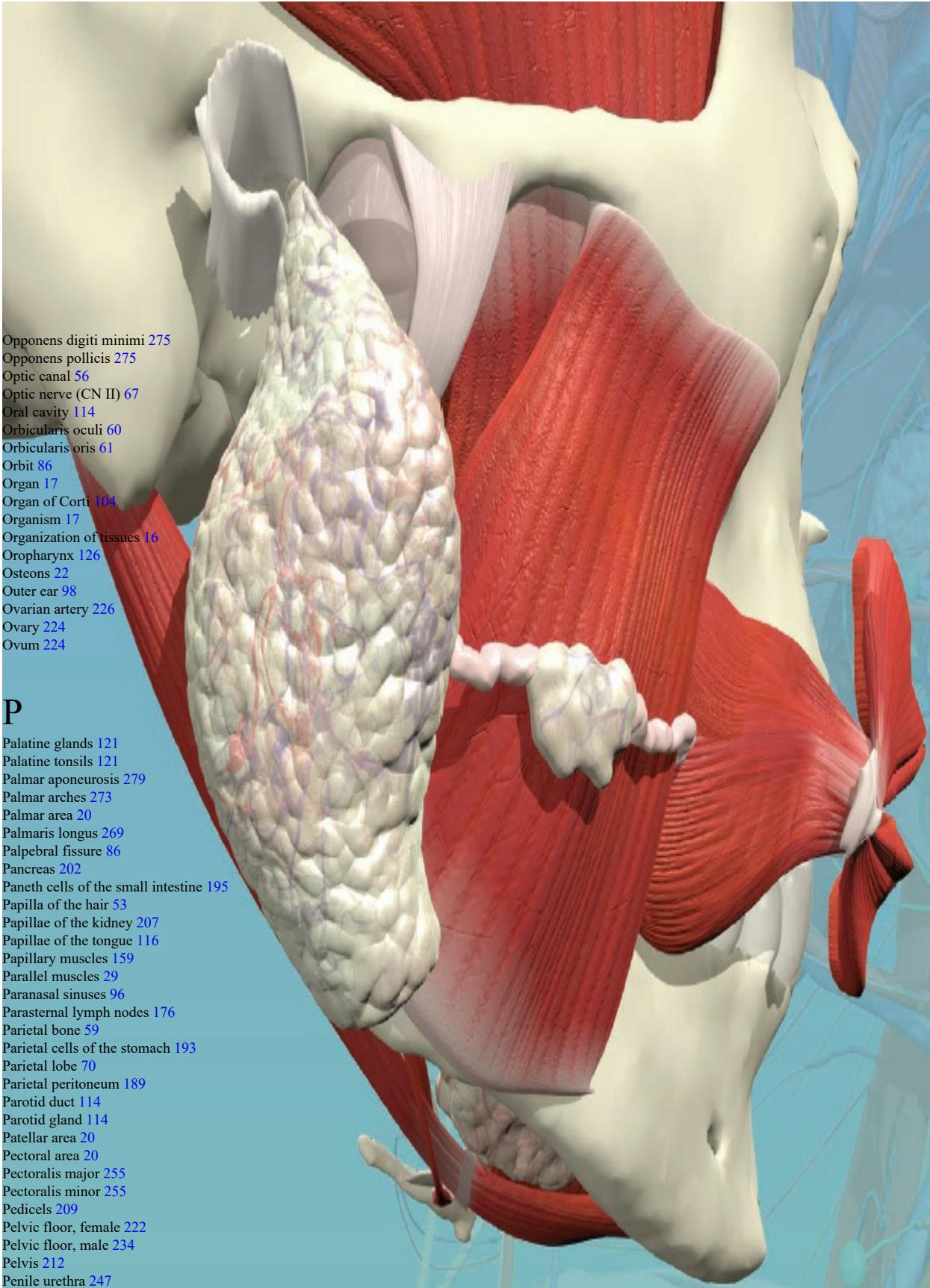
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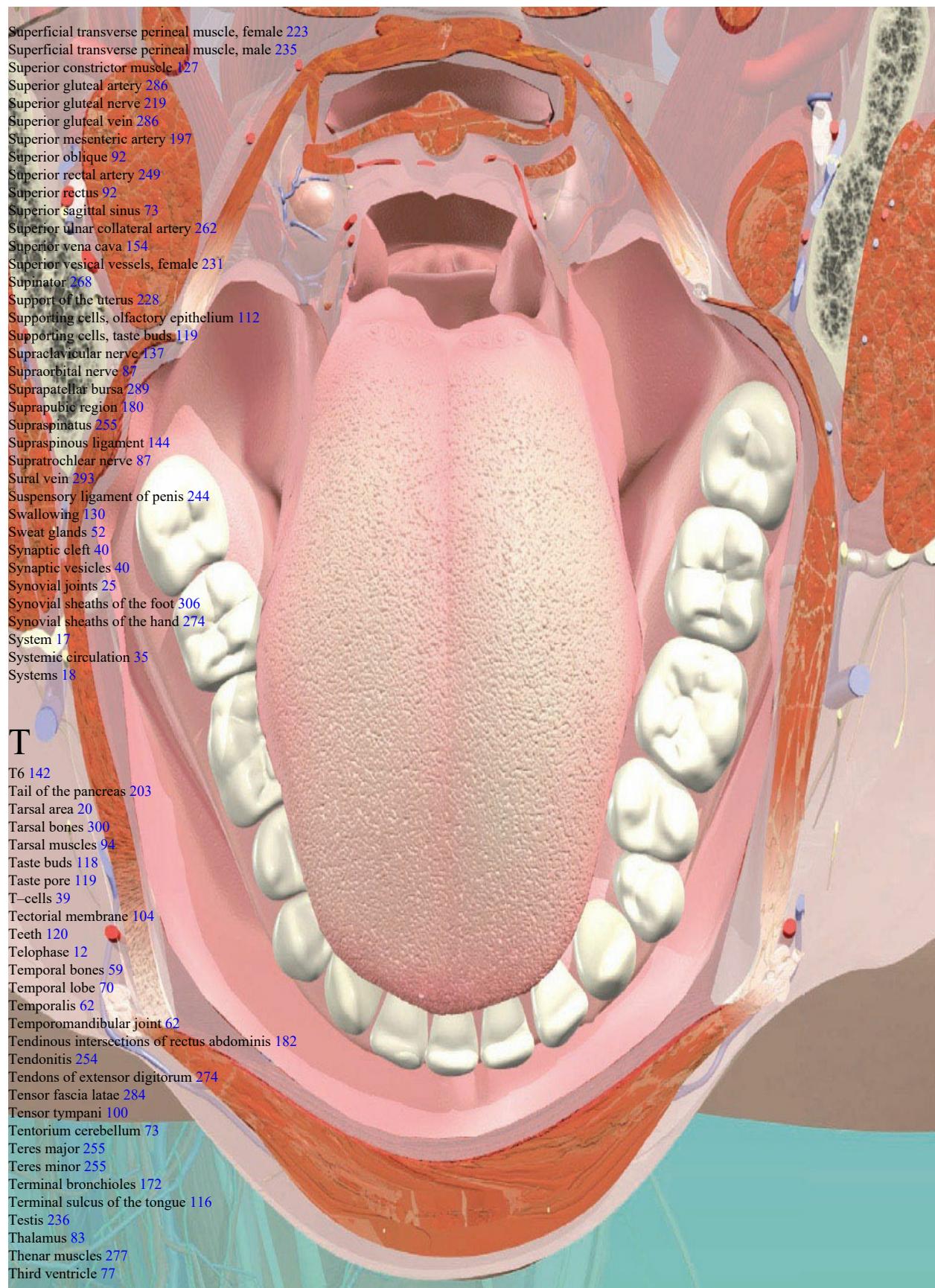


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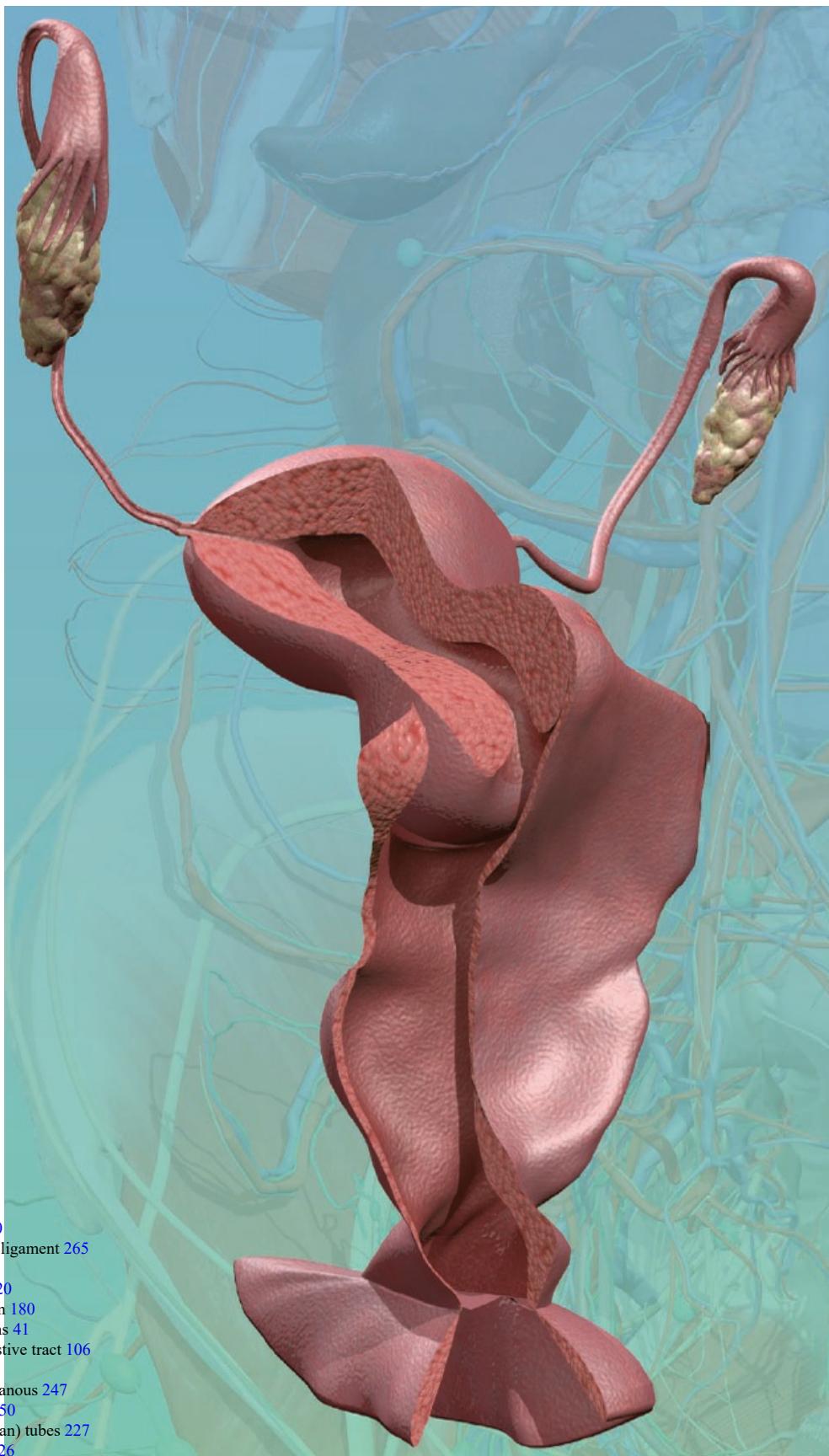
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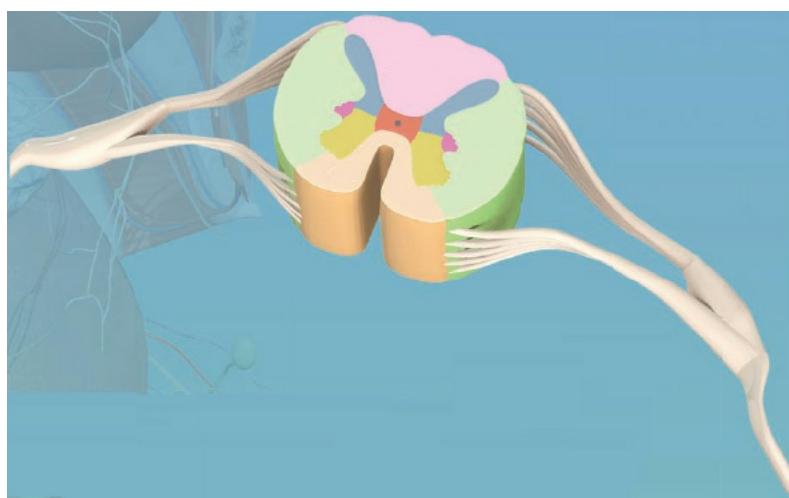
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